JOURNAL OF DAIRY SCIENCE

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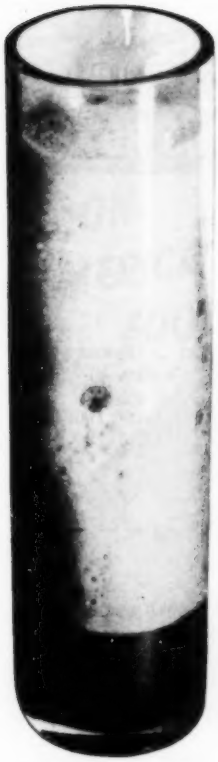

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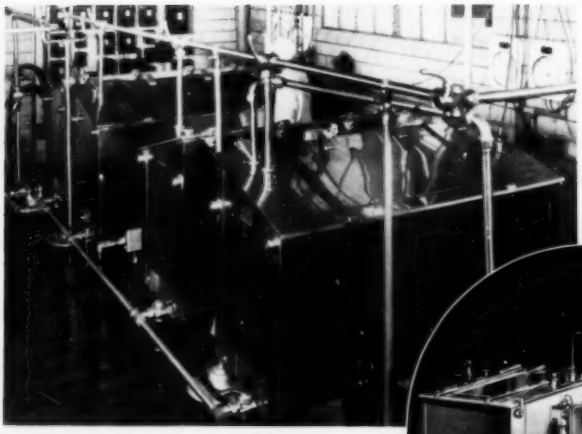

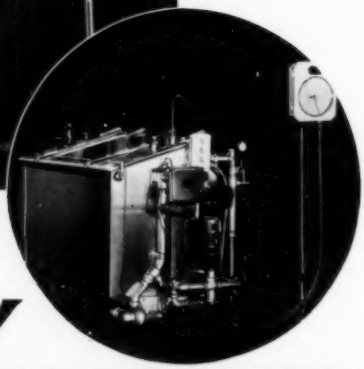

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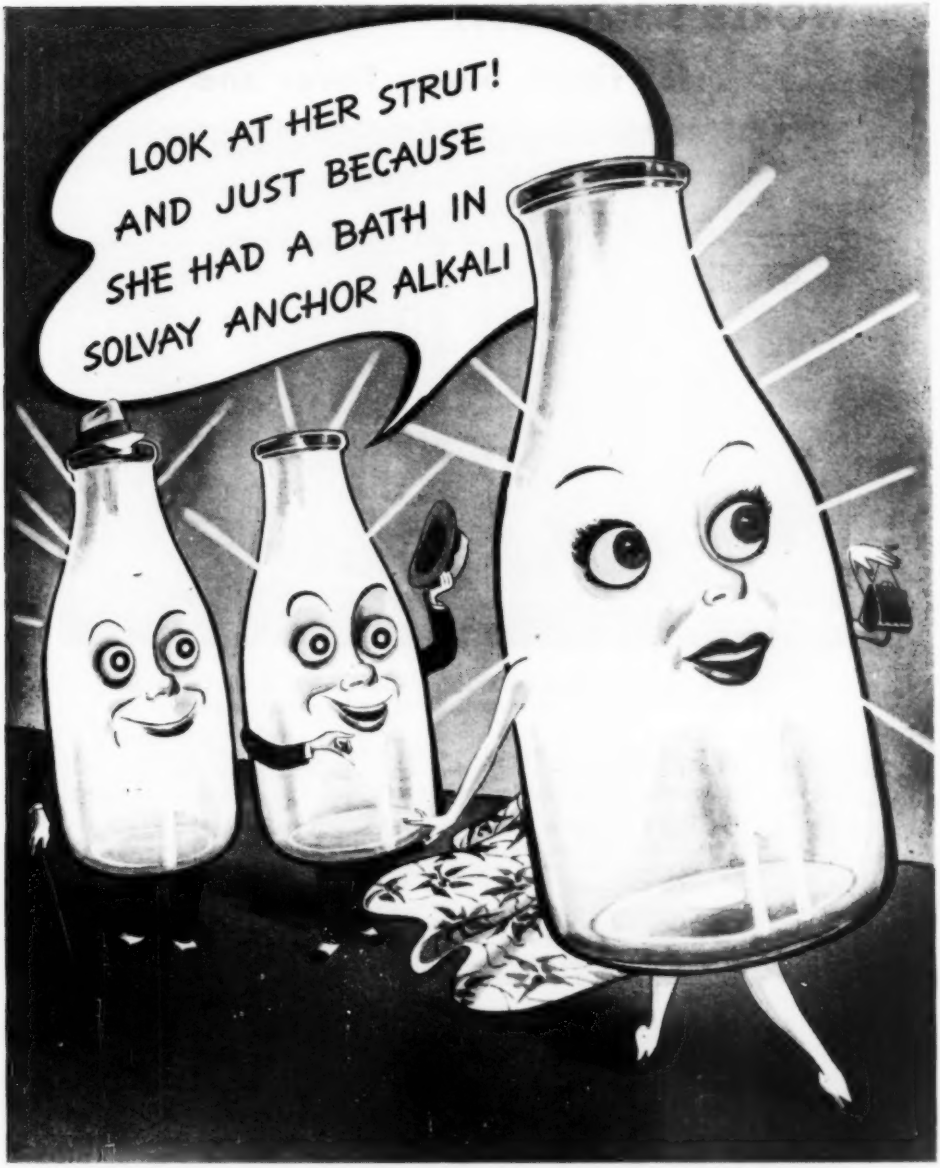

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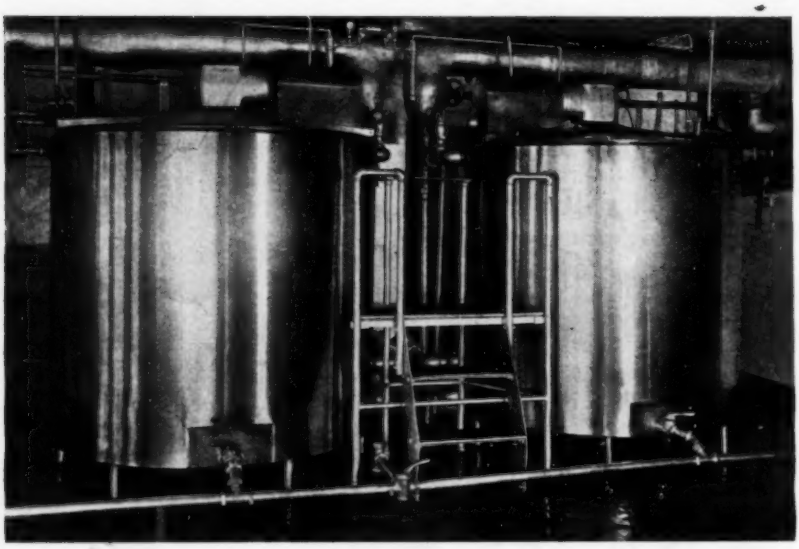

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JOURNAL OF DAIRY SCIENCE

VOLUME XXVII DECEMBER, 1944 NUMBER 12

RELATION OF VARIOUS FACTORS TO THE BREEDING EFFICIENCY OF DAIRY ANIMALS AND TO THE SEX RATIO OF THE OFFSPRING

R. A. HILDER, M. H. FOHRMAN, AND R. R. GRAVES

Bureau of Dairy Industry, Agricultural Research Administration, U. S. Department of Agriculture

Breeding efficiency is an important economic factor in maintaining or developing a dairy herd, especially when proved sires are used, and also in regulating the production of the herd to meet market conditions. Although a proved sire is usually expensive to purchase, his ultimate cost is determined largely by the length of time he maintains his breeding efficiency.

The breeding records of the dairy herd maintained by the Bureau of Dairy Industry at Beltsville, Md., have been studied in an effort to determine the relationship of various factors to the breeding efficiency of sires and dams and also to the sex ratio of the resulting offspring.

The Beltsville herd, which was established in 1912, consists largely of purebred Holstein-Friesian and Jersey cattle, a small group of Red Danish cattle that was added in 1936, and a few grade animals. The data used in this study consist largely of the records of the herd from 1919 to 1942, inclusive.

MANAGEMENT OF THE HERD

Since 1918 the major portion of the herd has been devoted to long-time breeding projects (1), which call for the use of a succession of unrelated proved sires. Linebreeding and inbreeding experiments are also being conducted.

An effort has been made to keep the management of this herd as uniform as possible. All cows are put on official test (365 days) during their first lactation and again after they are 5 years old. Test cows are kept in box stalls, milked three times daily, and are not given access to pasture. When the cows are not on test, they are milked twice daily in stanchions and are provided with pasture when available. All feeding is done according to feeding standards, the ration consisting chiefly of corn silage, alfalfa hay, and a grain mixture containing 15.5 per cent of digestible protein. During the test year the cows are bred 5 to 6 months after they calve, but during other lactations they are bred 3 to 4 months after calving.

Received for publication May 18, 1944.

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Careful attention is given to the care of the bulls. They are adequately housed and fed and are given 2 hours of exercise daily. Sprouted oats is a part of the bulls' ration.

Various diseases have occurred in the herd during the period covered by this study, including outbreaks of both tuberculosis and brucellosis, and at one time some evidence of trichomoniasis.

RESULTS OF THE STUDY

Effect of age of sire on breeding efficiency. In studying the effect of age on breeding efficiency, the males and females were first considered separately.

TABLE 1

Effect of age of sire on breeding efficiency

Age of sire (years)	Total services	Services to non-breeders	Services to fertile cows	Total conceptions	Services per conception
Under 1	30	2	28	10	2.80
1	996	245	751	336	2.24
2	918	210	708	337	2.10
3	748	174	574	254	2.26
4	651	141	510	199	2.56
5	749	163	586	220	2.66
6	989	254	735	272	2.70
7	1,348	289	1,059	416	2.55
8	1,446	291	1,155	385	3.00
9	1,325	285	1,040	320	3.25
10	1,078	310	768	242	3.17
11	584	95	489	155	3.15
12	370	116	254	90	2.82
13	148	61	87	31	2.81
14	145	72	73	29	2.52
15	107	43	64	26	2.46
16	56	21	35	16	2.19
17	5	2	3	1	3.00
Total or average	11,693	2,774	8,919	3,339	2.67

Table 1 shows the effect of the age of a sire on his breeding efficiency, as calculated from services to fertile cows only.

In general the number of services per conception shows a slight upward trend between the ages of 1 and 12 years. The number of cows served by bulls under 1 year of age and at 12 years and older is so small that uniformity cannot be expected. One break in the curve occurs at the age of 7 years. Most of the proved sires that were purchased came into the herd at about 7 or 8 years of age. It was thought that possibly the change in environment of these purchased sires had a temporary beneficial effect upon their efficiency. To test this theory, a tabulation was made of the breeding records of eight Beltsville-bred sires that were in regular service at the station during their entire lifetime (in all cases at least 9 years) (see table 2). These eight sires show a greater increase in breeding efficiency from

the age of 6 to 7 years than is shown by the sires in table 1. We have no explanation for the increase in breeding efficiency from 6 to 7 years of age by either group of sires.

Effect of age of female on breeding efficiency. Table 3 shows the effect of age of the female on breeding efficiency. The data are based on the age of the cows at the time of conception. All breedings to fertile sires are included. In cases where the records show that a bull was obviously declining in fertility toward the end of his active service he is considered sterile after the date of his last successful service, and breedings after that date are not charged against the cows.

Here again the older groups are small and the figures cannot be considered conclusive. However, until females are 9 years of age, their age has

TABLE 2

Average breeding efficiency of 8 Beltsville-bred sires at various ages

Age of bulls (years)	Total services	Services to non-breeders	Services to fertile cows	Total conceptions	Services per conception
1	175	63	112	48	2.33
2	244	72	172	86	2.00
3	299	81	218	86	2.53
4	249	46	203	76	2.67
5	299	48	251	83	3.02
6	440	119	321	100	3.21
7	368	100	268	105	2.55
8	219	65	154	61	2.52
9	102	37	65	13	5.00
10	64	35	29	13	2.23
Total or average	2,459	666	1,793	671	2.67

little apparent effect upon their breeding efficiency. These figures do not show the marked decrease in number of services required for conception after 2 years of age that was found by Morgan and Davis (3). The 2–3-year-old group is made up largely of cows being bred for their second gestation, but a considerable number of heifers being bred for their first gestation are also included in this age-group. Most of the heifers in this herd are bred first at about 15 months of age, so it is obvious that these "carry-overs" required a large number of services. Probably this factor is a disturbing influence among the younger age-groups. The 1–2-year-old group required an average of 2.55 services per conception, while the 2–3-year-old group required 2.57 services per conception. If the first-gestation heifers are taken out of the 2–3-year-old group and included in the 1–2-year-old group, the figures become 2.88 services per conception for the first-gestation group and 1.97 for the 2–3-year-old cows. Possibly this affords a truer measure of the breeding efficiency of younger cows than a grouping strictly according to ages.

TABLE 3

Effect of age of female on breeding efficiency

Age of cows (years)	Total services	Number cows conceiving on service No.											Total conceptions	Services per conceptions
		1	2	3	4	5	6	7	8	9	10	11 and over		
1–2	2,286	398	165	120	74	47	39	30	9	6	3	6	897	2.55
2–3	1,573	293	119	65	41	34	15	8	9	5	11	12	612	2.57
3–4	1,255	247	100	57	30	29	15	10	10	2	5	4	509	2.47
4–5	1,233	180	98	63	38	20	17	6	6	7	5	9	449	2.75
5–6	1,023	153	73	45	18	18	11	7	6	3	2	14	350	2.92
6–7	643	134	48	32	15	15	11	5	1	4	.....	3	268	2.40
7–8	552	78	31	35	18	7	4	4	3	3	2	5	190	2.91
8–9	327	48	26	15	7	8	2	4	3	1	.....	3	117	2.79
9–10	250	36	14	7	5	10	6	2	3	.....	1	1	85	2.94
10–11	106	14	10	9	3	1	.....	2	.....	.....	.....	1	40	2.65
11–12	67	8	4	4	4	.....	1	.....	1	1	.....	.....	23	2.91
12–13	27	1	2	2	1	.....	2	.....	.....	.....	.....	.....	8	3.38
13–14	10	2	.....	1	.....	1	.....	.....	.....	.....	.....	.....	4	2.50
14–15	7	4	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	5	1.40
Total or average	9,359	1,596	690	456	254	190	123	78	51	32	29	58	3,557	2.63
Per cent of total*		44.9	19.4	12.8	7.1	5.3	3.5	2.2	1.4	0.9	0.8	1.6		

* 77.1% conceived on first 3 services; 89.6% conceived on first 5 services.

Table 3 also shows the number of conceptions that occurred from various numbers of services for each age-group. It will be noted that, for all ages, 77.1 per cent conceived in three services or less and 89.6 per cent conceived in five services or less. These figures may throw some light on the question of how long a cow should be retained in an effort to get her with calf. Of course, many factors must be considered, but unless the cow is particularly valuable it seems doubtful that more than five services would be warranted in a commercial herd. Normally the time required for five services is approximately 3 months, and some additional time must elapse before pregnancy can be definitely determined. These precentages are particularly impressive in view of the fact that in this herd the cows that fail to conceive

TABLE 4

Effect of age of both parents on breeding efficiency

Cows' gestation number	Bulls under 5 years			Bulls 5 years and over			All bulls		
	Number services	Number conceptions	Services per conception	Number services	Number conceptions	Services per conception	Number services	Number conceptions	Services per conception
1	802	421	1.90	1,309	431	3.04	2,111	852	2.48
2	385	206	1.87	1,122	497	2.26	1,507	703	2.14
3	271	137	1.98	910	397	2.29	1,181	534	2.21
4	183	101	1.81	726	295	2.46	909	396	2.30
5	139	66	2.10	508	230	2.21	647	296	2.19
6	82	40	2.05	344	152	2.26	426	192	2.22
7	53	23	2.30	210	85	2.47	263	108	2.44
8	23	15	1.53	84	40	2.10	107	55	1.95
9	7	5	1.40	65	26	2.50	72	31	2.32
10	.....	.....	.....	23	12	1.92	23	12	1.92
11	.....	.....	.....	10	5	2.00	10	5	2.00
12	.....	.....	.....	7	3	2.33	7	3	2.33
13	.....	.....	.....	1	1	1.00	1	1	1.00
14	.....	.....	.....	1	1	1.00	1	1	1.00
Total or average	1,945	1,014	1.92	5,320	2,175	2.45	7,265	3,189	2.28

promptly receive veterinary treatment. Such treatment would not be available in the average commercial herd.

Effect of age of both parents on breeding efficiency. A comparison of the breeding efficiency of young and old sires when bred to cows of varying ages is shown in table 4. The cows are grouped according to gestation rather than age. The data are omitted for all cows bred to more than one sire for a single conception. These figures show that the young bulls are more efficient than the older ones on cows of all ages, but their greatest margin over the older bulls was on the first-gestation heifers.

As in most of the other tabulations, the groups of older cows are small and the figures are therefore not conclusive. It cannot be assumed that all old bulls will not breed heifers efficiently. To illustrate this point a calculation was made of the breeding records of 4 Jersey bulls that were returned

TABLE 5

Effect of age of parents on sex ratio

Age of sire (years)	Percentage of male calves born when cow's age at time of conception was											Total male progeny	Total female progeny	Per cent male progeny
	1 year	2 years	3 years	4 years	5 years	6 years	7 years	8 years	9 years	10 years	11 years and over			
1	48.7	55.2	67.9	44.8	43.5	38.5	50.0	66.7	66.7	100.0	.....	169	160	51.4
2	44.6	69.2	47.4	58.8	66.7	50.0	43.8	54.5	60.0	50.0	0.0	188	175	51.8
3	48.6	52.4	68.6	43.8	59.1	62.5	63.6	80.0	0.0	66.7	100.0	147	127	53.6
4	55.4	59.5	75.0	67.9	42.1	53.3	42.9	16.7	40.0	66.7	33.3	123	93	56.9
5	65.4	52.8	44.8	54.8	54.2	38.1	63.6	77.8	40.0	40.0	66.7	124	102	54.9
6	46.8	43.9	65.1	45.5	54.8	68.0	61.5	63.6	55.6	50.0	80.0	162	142	53.3
7	52.8	60.6	48.3	53.8	45.7	41.7	47.1	60.0	50.0	33.3	20.0	208	196	51.5
8	59.3	54.7	60.4	50.0	51.1	54.1	59.1	44.4	50.0	25.0	100.0	214	173	55.3
9	59.3	33.3	57.6	44.2	53.7	51.6	36.0	70.0	57.1	.....	100.0	168	169	49.9
10	54.3	57.9	62.8	50.0	52.0	44.0	75.0	72.7	50.0	50.0	50.0	139	108	56.3
11	63.3	58.1	70.4	51.9	52.2	83.3	28.8	50.0	33.3	.....	.....	102	75	57.6
12	33.3	50.0	61.5	30.8	83.3	20.0	37.5	25.0	75.0	0.0	66.7	38	44	46.3
13 & over	0.0	63.2	50.0	37.5	50.0	44.4	27.3	16.7	71.4	25.0	60.0	45	51	46.9
Total or average	52.1	54.0	58.9	50.1	52.4	51.0	49.2	56.8	52.6	42.9	60.0	1,827	1,615	53.1

NOTE: Monosexual twins counted as one calf. Bisexual twins omitted.

to Beltsville after several years of service in cooperators' herds. Their average age at the time of starting service at Beltsville was 7 years 8 months. Their arverage breeding efficiency on 69 virgin heifers was 1.84 services per conception, or slightly better than the average for all bulls under 5 years of age.

In 1935 a practice was started of reserving certain young bulls for use with virgin heifers only. This was based on the theory that the herd bulls might be transferring infection from the older cows to the heifers, thus making it difficult to get them with calf. The average age of the young bulls was 3 years 1 month at the time of their last service to the virgin heifers. Seven of these bulls obtained 164 conceptions from 279 services, an average of 1.70 services per conception. This average is significantly lower than the average for all bulls under 5 years of age when bred to heifers.

Effect of age of parents on sex ratio. Table 5 shows the effect of the age of the parents on the sex ratio of the offspring. The tabulation is based on the age of each parent at the time of conception. There seems to be no indication that the age of the parents has any particular effect on the sex ratio of the offspring. The only conclusion from these figures is that the normal expectancy is a slight preponderance of males. This conforms to the findings of other workers.

Effect of calving interval on breeding efficiency. A theory has been advanced that a cow bred to calve 12 months after freshening will conceive more readily than one bred for a longer calving interval. Since it was the practice in this herd to breed the cows for a 15-month calving interval during test years and for a 12-month interval during other lactations, it is possible to compare these two calving intervals in the same herd. Among the Jerseys and Holsteins 432 cows required 2.54 services per conception when bred to calve in 15 months, while 431 cows required 2.69 services per conception when bred to calve in 12 months. This difference could hardly be called significant.

Effect of season on breeding efficiency and sex ratio. In order to determine whether the season of the year has any effect on breeding efficiency, the service record of each sire was compiled by months. The summary for all sires is given in table 6. The data show an increase in services per conception during July, August, and September. The number also increased during February and March. The seasonal trend in breeding efficiency at the Beltsville station is similar to that reported for the University of Nebraska herd (3), except that the periods of lowest efficiency occur about a month later at the Nebraska station than at Beltsville. (See figure 1.)

The period of lowest fertility during midsummer may be due in part to high temperatures and their direct physiological effect on the animals. Phillips *et al.* (4) in a study of seasonal variation in bull semen, report that most measures of quality in semen indicate it is of lower quality during the summer months than during the rest of the year. No explanation is avail-

able for the increase in services required for conception during the late winter season.

There is no evidence in the data to show that season has any effect on sex ratio.

Yearly variation in breeding efficiency. Table 7 shows the variation in breeding efficiency from year to year. This tabulation is based on the same figures as those in table 6, combined by years instead of by months. There appears to be a tendency for the fertility to be lowest in the years following those in which the greatest percentage of abortions occurred. This bears out the findings of Miller, Graves, and Fohrman (2) who found that fertility decreases after abortions caused by brucellosis, but not after abortions that result from other causes. In 1925 and 1926, when the percentage of abor-

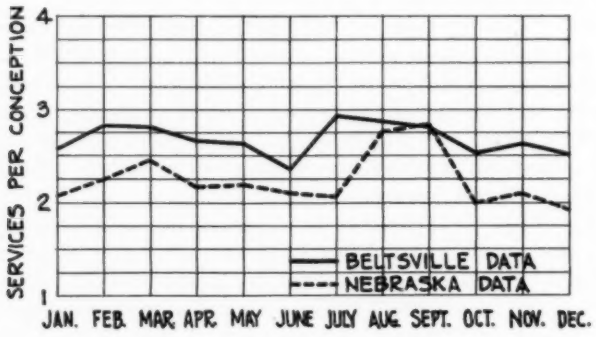

FIG. 1. Effect of season on breeding efficiency.

tions was very high in the Beltsville herd, brucellosis was responsible for a large proportion of the abortions.

BREEDING PROBABILITIES

Table 8 is a compilation of the breeding records of 725 cows in the Beltsville herd for which the entire life history is available. The breeding records of these cows are an indication of the number of replacements that must be made to maintain a dairy herd. For example, only 449 of the original 725 cows, or 61.9 per cent, were bred for the third calf, and only 393 of these conceived for the third time. There have been two serious outbreaks of disease in this herd in the past 25 years, and for this reason the figures may not be representative of an average cow population. Two factors, however, at least partially offset the effect of these disease epidemics: 1) No culling for low production was practiced, and 2) some of the cows that reacted to the tuberculosis and brucellosis tests were not disposed of immediately, but were isolated from the rest of the herd and retained for breeding purposes.

In the various tables presented in this study, the average number of services per conception is not always the same since the groups are composed

TABLE 6

Effect of season of the year on breeding efficiency and sex ratio

Month of conception	Number cows bred	Total services	Services to fertile cows	Per cent of conceptions on service No.*				Total conceptions	Result of conception†			Services per conception
				1	2	3	4 and over		Living calves	Per cent abortions	Per cent male progeny	
Jan.	830	955	739	46.7	21.3	10.8	21.2	287	231	9.4	53.9	2.57
Feb.	794	899	695	47.3	21.1	13.4	18.2	247	192	14.2	50.9	2.81
Mar.	875	1,028	795	48.9	19.1	14.4	17.6	284	226	8.5	50.9	2.80
Apr.	923	1,061	825	56.6	15.8	10.6	17.0	311	252	9.6	54.2	2.65
May	950	1,097	864	48.0	19.9	11.9	20.2	327	260	10.7	53.0	2.64
June	851	954	725	48.2	17.3	10.1	24.4	307	255	6.2	51.9	2.36
July	796	918	703	50.6	18.0	10.9	20.5	239	196	7.5	52.0	2.94
Aug.	892	1,049	778	44.1	21.1	17.0	17.8	270	207	9.6	54.5	2.88
Sept.	884	1,017	761	46.7	23.0	13.3	17.0	270	214	8.5	53.8	2.82
Oct.	938	1,077	813	47.2	19.3	12.4	21.1	322	242	12.4	52.5	2.52
Nov.	842	947	732	52.0	21.3	13.4	13.3	277	224	7.2	58.8	2.64
Dec.	865	986	751	54.4	19.5	11.4	14.7	298	239	8.1	51.6	2.52
Total or average	.....	11,988	9,181	49.3	19.6	12.4	18.7	3,439‡	2,738	9.3	53.2	2.67

* Services to one sire only.

† Monosexual twins counted as one calf. Bisexual twins omitted.

‡ 81.3% of conceptions obtained on first 3 services; 93.1% of conceptions obtained on first 5 services.

TABLE 7

Yearly variation in breeding efficiency and sex ratio

Year	Number cows bred	Total services	Services to fertile cows	Per cent of conceptions on service No.*				Total conceptions	Result of conception†			Services per conception
				1	2	3	4 and over		Living calves	Per cent abortions	Per cent male progeny	
1917	1	1	1	100.0	.....	.....	.....	1	1	0.0	0.0	1.00
1918	12	25	25	25.0	50.0	25.0	.....	4	2	50.0	0.0	6.25
1919	35	48	38	86.4	4.5	9.1	.....	22	14	13.6	50.0	1.73
1920	44	83	48	77.3	9.1	9.1	4.5	22	18	13.6	52.4	2.18
1921	86	216	169	47.0	12.1	16.7	24.2	66	45	25.8	56.5	2.56
1922	98	268	215	51.7	18.3	10.0	20.0	60	48	15.0	43.6	3.58
1923	148	368	300	52.2	12.0	14.1	21.7	92	78	8.7	48.8	3.26
1924	134	323	224	58.4	11.2	7.9	22.5	89	70	16.9	51.2	2.52
1925	162	422	286	50.0	22.2	15.7	12.1	108	66	29.6	54.5	2.65
1926	179	470	360	46.0	17.7	14.5	21.8	124	81	25.8	53.1	2.90
1927	162	434	344	43.4	15.0	13.3	28.3	113	87	8.8	52.8	3.04
1928	199	403	330	60.2	13.5	8.3	18.0	133	104	10.5	63.5	2.48
1929	208	471	365	49.0	18.2	15.4	17.4	143	113	14.7	45.7	2.55
1930	266	639	474	48.2	22.3	12.0	17.5	166	132	9.4	54.7	2.86
1931	271	665	473	44.4	20.6	13.1	21.9	160	109	16.9	50.0	2.96
1932	289	783	541	49.4	22.2	12.2	16.2	180	136	10.0	52.1	3.01
1933	260	727	534	44.5	20.9	13.2	21.4	182	150	3.3	61.3	2.93
1934	256	644	515	47.7	14.0	10.4	27.9	193	159	7.3	55.5	2.67
1935	274	696	555	35.3	22.9	16.5	25.3	170	127	5.9	61.0	3.26
1936	215	480	373	47.3	25.7	9.0	18.0	167	131	8.4	52.6	2.23
1937	202	466	386	51.9	15.6	13.0	19.5	154	131	3.9	52.1	2.51
1938	243	598	441	49.7	24.5	9.7	16.1	155	139	1.9	51.0	2.85
1939	288	636	482	55.0	23.3	11.6	10.1	189	170	3.7	43.5	2.55
1940	346	838	672	47.2	19.6	14.8	18.4	271	236	5.9	52.1	2.48
1941	331	663	515	50.8	25.6	10.2	13.4	246	198	4.5	54.4	2.09
1942	229	621	515	52.0	19.2	13.1	15.7	229	193	3.5	55.0	2.25
Total or average	.....	11,988	9,181	49.3	19.6	12.4	18.7	3,439	2,738	9.3	53.2	2.67

* Services to one sire only.

† Monosexual twins counted as one calf. Bisexual twins omitted.

TABLE 8

Life-time breeding records of 725 cows in the Beltsville herd

Gestation number	Number cows not bred for this gestation	Cows bred		Number of non-breeders	Number cows failed to conceive*	Number cows conceived	Per cent of cows conceiving on service No.				Services per conception
		Number	Per cent				1	2	3	4	
1	.....	725	100.0	27	21	677	33.4	14.8	12.6	32.7	3.23
2	83	594	81.9	41	25	528	41.4	17.5	12.5	17.5	2.41
3	79	449	61.9	39	17	393	39.2	17.8	8.5	22.0	2.83
4	80	313	43.2	21	11	281	37.1	20.8	13.1	18.8	2.67
5	53	228	31.4	18	11	199	40.8	18.4	11.4	16.7	2.35
6	41	158	21.8	19	12	127	35.4	11.4	19.0	14.6	2.50
7	32	95	13.1	15	5	75	32.6	14.7	10.5	21.0	2.73
8	18	57	7.9	8	5	44	35.1	12.3	15.8	14.0	2.30
9	13	31	4.3	6	1	24	19.4	22.6	19.4	16.2	2.67
10	9	15	2.1	4	2	9	26.7	13.3	6.7	13.4	2.33
11	4	5	0.7	1	.....	4	40.0	20.0	.....	20.0	2.25
12	1	3	0.4	.....	1	2	.....	.....	66.7	.....	3.00
13	1	1	0.1	.....	.....	1	100.0	.....	.....	.....	1.00
14	.....	1	0.1	.....	.....	1	100.0	.....	.....	.....	1.00
Total or average	.....	2,675	.....	199	111	2,365	37.2	16.7	12.3	22.2	2.76

* This column includes cows that received one or more services but died or were eliminated from the herd for causes other than sterility.

of different animals. As was mentioned before, the early records of this station were not always complete, which rendered some of the data suitable for some types of calculation but not for others.

SUMMARY

The breeding records of the Bureau of Dairy Industry herd at Beltsville, Md., have been studied from the standpoint of breeding efficiency and sex ratio of offspring as influenced by the ages of the cows and bulls and by the season of the year.

The sires showed a gradual lessening of breeding efficiency with advancing age, with the exception of the 7-year-old group. No explanation can be offered for the decrease that occurred in number of services per conception at this age.

After the first gestation, age had little apparent effect upon the breeding efficiency of the cows. Heifers being bred for the first time required more services than the older cows.

Bulls over 5 years of age showed a distinctly higher number of services per conception than did young bulls when bred to heifers being bred for their first gestation. Young bulls that were bred exclusively to virgin heifers proved even more efficient than the whole group of young bulls.

Breeding efficiency of the cows was not appreciably affected by length of calving interval.

The most noticeable effect of season on breeding efficiency was the relatively large number of services required for conception during midsummer, followed by a sharp decrease in the fall.

Data showing the yearly variation in breeding efficiency indicate that there was a tendency for the years of lowest breeding efficiency to follow years when the percentage of abortions was highest.

A tabulation of the complete breeding life histories of 725 cows in the Beltsville herd indicates the probable breeding losses in a dairy herd from various causes.

There is no evidence that any of the factors studied influenced the sex ratio of the offspring.

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BACTERIOLOGICAL EVALUATION OF ICE CREAM[1]

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The standard plate count, usually with incubation at 37° C., has been used almost to the exclusion of other possible means for determination of "total" numbers of bacteria in ice cream. The studies reported here seek to establish whether certain of the other methods used for dairy products may be substituted.

I. THE RESAZURIN AND METHYLENE-BLUE REDUCTION TESTS

Although both the resazurin and the methylene-blue reduction tests have been used quite widely on unpasteurized milk and to some extent on pasteurized milk and cream, they apparently have not been employed extensively for bacteriological evaluation of ice cream or ice cream mix. The simplicity and inexpensiveness of these tests commend them to use where applicable.

METHODS

Factory-packed pint samples of ice cream, each from a different manufacturer, were shipped with dry-ice refrigeration to the laboratory, where they were held in the ice cream hardening room until analyzed. Data in parts II and III were obtained from the same set of samples. The ages of the different samples were not known. The plate counts were obtained by using the volumetric procedure (1). The methylene-blue tests were made according to the Standard Methods procedure for milk, using methylene-blue thiocyanate tablets (1). The tubes were examined at one-half hour intervals, but they were not inverted at examination. The resazurin tests were made by adding 0.1 ml. of a 0.05 per cent solution of Eastman resazurin to each 10 ml. quantity of melted ice cream, which then was handled in the same manner as the methylene-blue tests. The time required for the milk to become a definite pink, free from blue, and the color changes at one and three hours were recorded.

Thornton and Hastings (9) reported the presence of cysteine hydrochloride accelerated dye reduction. In one series of the methylene blue tests, 0.2 ml. of freshly prepared N/10 cysteine hydrochloride was added to the ice cream–dye mixture before incubation. This amount was found by

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TABLE 1

Relationship of standard plate count and resazurin reduction time

Standard plate count per ml.	No. of samples with resazurin reduction time (min. to pink stage) of										Totals
	0–60	90–120	150–180	210–240	270–300	330–360	390–420	450–480	510–540	More than 540	
10,000 or less	1	.....	.....	.....	3	5	2	23	4	9	47
10,100–25,000	.....	.....	.....	1	5	12	5	12	1	1	37
26,000–50,000	.....	1*	.....	3	5	3	.....	3	.....	1	16
51,000–100,000	.....	1	2	1	6	4	3	4	2	.....	23
101,000–200,000	.....	.....	2	4	6	4	.....	1	1	.....	18
201,000–500,000	.....	.....	3	2	2	.....	.....	.....	.....	.....	7
510,000–1,000,000	2*	1	3	3	.....	.....	.....	.....	.....	.....	9
1,010,000–3,000,000	1	4	4	.....	.....	.....	.....	.....	.....	.....	9
3,100,000–10,000,000 ...	4	4	.....	.....	.....	.....	.....	.....	.....	.....	8
Greater than 10,000,000 ...	5	1	.....	.....	.....	.....	.....	.....	.....	.....	6
Totals	13	12	14	14	27	28	10	43	8	11	180

* High direct microscopic count.

preliminary experiment to increase the rate of reduction without causing extremely rapid decolorization.

RESULTS

A general relationship between standard plate count and resazurin reduction tests, using the time required for attainment of a pure pink color as the resazurin end-point, is apparent from the data presented in table 1. Had a standard of greater than 240 minutes to reduce the dye to the pink end-point been adopted, only two of 39 samples with place counts about 200,000 per ml. would have been accepted; and ten samples with counts below 100,000 per ml. would have been rejected. One of the latter samples had a

TABLE 2

Relationship of resazurin color change after incubation at 37° C. for 1 and 3 hours and standard plate count on 177 samples of ice cream

Standard plate counts per ml.	Number of samples after 1 hour incubation falling in color class				Totals	Number of samples after 3 hours incubation falling in color class			
	1*	2	3	4		1*	2	3	4
10,000 or less	42	2[b]	1[c]	1	46	38	6[b]	1[c]	1
10,100–25,000	37	1	.....	.....	38	29	9	.....	.....
26,000–50,000	13	4	.....	.....	17	9	7	.....	1[d]
51,000–100,000	19	3	.....	.....	22	12	7	3	.....
101,000–200,000	13	4	.....	.....	17	5	8	3	1
201,000–500,000	5	1	.....	.....	6	.....	3	2	1
510,000–1,000,000	5	2	2	.....	9	.....	2	2	5
1,010,000–3,000,000	1	7	1	.....	9	.....	.....	4	5
3,100,000–10,000,000	.....	2	3	2	7	.....	.....	1	6
Greater than 10,000,000	.....	1	1	4	6	.....	.....	.....	6
Totals	135	27	8	7	177	93	42	16	25

* 1 = no color change.
2 = definite change to lavender.
3 = pink devoid of lavender.
4 = white.

[b] = two samples with high direct microscopic counts.
[c] = one sample with high direct microscopic count.
[d] = abnormal color change in dye.

very high direct microscopic count, indicating that the resazurin test may have been more accurate than the plate count in this instance. Direct microscopic counts were not available on most of the remaining samples which would have been rejected. No other end-point, with the possible exception of 180 minutes, would have given a comparable degree of separation of the high-count samples from those with low counts.

The data of table 2 show that color changes at one hour failed to permit separation of the samples into satisfactory groups based upon plate counts. The plate counts of the four classes established by color change at three hours overlapped considerably from class to class; but those samples in which the indicator had turned either definite pink or colorless in three

TABLE 3

Relationship of standard plate count and methylene-blue reduction time

Standard plate count per ml.	No. of samples with methylene-blue reduction time (min.) of										Totals
	0–60	90–120	150–180	210–240	270–300	330–360	390–420	450–480	510–540	> 540	
10,000 or less	.....	1	.....	.....	.....	3	1	26	4	12	47
10,100–25,000	.....	.....	.....	.....	1	5	13	13	4	1	37
26,000–50,000	.....	1	.....	1	3	4	2	3	.....	2	16
51,000–100,000	.....	.....	.....	2	5	4	4	4	2	2	23
101,000–200,000	.....	.....	1	2	4	4	2	4	.....	1	18
201,000–500,000	.....	.....	1	2	2	1	1	.....	.....	.....	7
510,000–1,000,000	.....	1	2	2	4	.....	.....	.....	.....	.....	9
1,010,000–3,000,000	.....	3	1	4	1	.....	.....	.....	.....	.....	9
3,100,000–10,000,000	1	3	2	.....	1	1	.....	.....	.....	.....	8
Greater than 10,000,000	4	1	1	.....	.....	.....	.....	.....	.....	.....	6
Totals	5	10	8	13	21	22	23	50	10	18	180

TABLE 4

Relationship of standard plate count and methylene-blue reduction time with cysteine added

Standard plate count per ml.	No. of samples with methylene-blue reduction time (min.) of										Totals
	30	60	90	120	150	180	210	240	270	300 or over	
10,000 or less	3	1	3	3	4	2	6	11	....	5	38
10,100–25,000	....	7	6	4	3	6	....	2	....	3	31
26,000–50,000	2	2	3	3	2	3	1	1	....	....	17
51,000–100,000	....	4	4	....	4	4	1	1	1	2	21
101,000–200,000	....	6	4	3	1	2	....	....	....	....	16
201,000–500,000	1	2	1	1	....	....	....	....	....	....	5
510,000–1,000,000	1	....	4	1	....	....	....	....	....	....	6
1,010,000–3,000,000	2	1	2	1	....	1	....	....	....	....	7
3,100,000–10,000,000	1	2	....	1	....	....	....	....	1	....	5
Greater than 10,000,000	4	....	1	....	....	....	....	....	....	....	5
Totals	14	25	28	17	14	18	8	15	2	10	151

hours were bacteriologically unsatisfactory by either the plate count or the direct microscopic count in nearly all instances. This was true especially of those samples which had reduced the dye to the colorless end-point.

A general relationship between methylene-blue reduction time and standard plate count on 181 samples of ice cream is shown in table 3, although the spread in counts in each dye reduction class is considerable. Segregation on the basis of methylene-blue reduction times of samples with either high or low plate counts does not appear possible without the misplacing of a considerable number of samples, particularly some with relatively high counts.

The data on 151 samples presented in table 4 indicate that a considerable decrease in methylene-blue reduction time resulted from the addition of cysteine hydrochloride; but the relationship between results of the usual methylene-blue reduction test and the standard plate count was decreased considerably by this addition. The results show little promise of practical application.

DISCUSSION

The possible limitations of the plate count as a basis of evaluation of other bacteriological tests are recognized, but other bases of evaluation available at present are subject to at least an equal number of potential limitations. The common use of the plate count for bacteriological control of ice cream makes desirable evaluation in terms of the plate count of newer methods such as reduction tests.

The data herein reported indicate that the resazurin reduction test, employing either the time required for the dye to become a definite pink or the color after incubation for three hours as the end-point, has possibilities as a means of segregating the majority of the ice cream samples with high standard plate counts from most of the samples with relatively low counts.

The methylene-blue reduction test appears to be less suited than the resazurin test as a simple method of determining the bacterial content of ice cream. Possibly the conditions of ice cream storage are such that the flora of the product is capable of only mild reducing activity, even when present in considerable numbers; and the more easily reduced resazurin is affected to a greater degree by the same population than is the less easily reduced methylene blue. Addition of cysteine hydrochloride to the methylene-blue reduction tests hastens reduction but weakens the relationship between numbers of bacteria and time of reduction.

CONCLUSIONS

1. The resazurin test, using either time for the color to become completely pink or the color of the indicator after three hours as the end-point, showed possibilities as a means of segregating samples of ice cream with high standard plate counts. The one-hour test showed little promise.

2. Segregation on the basis of the methylene-blue reduction test of ice cream samples with high plate counts did not seem practical upon the basis of results obtained in this study.

3. Addition of 0.2 ml. of N/10 cysteine hydrochloride to each methylene-blue test shortened the reduction time but disrupted the relationship between reduction time and standard plate count.

II. PLATE COUNTS AT 45° AND 55° C.

Although plate counts employing incubation temperatures above 37° C. have been used with some success in the bacteriological evaluation of milk and cream, such procedures apparently have not been employed to any extent in testing ice cream. The studies reported here attempt evaluation of plate counts at 45° and 55° C. for determination of bacteriological quality of ice cream.

METHODS

The volumetric procedure (1) was employed in preparation of all plates. Duplicate plates of each dilution of each sample were incubated for 48 ± 3 hours at 37°, 45° and 55° C.

RESULTS

The data showing the relationship between plate counts at 37° C. and 55° C. for 121 samples are presented in table 5. Of the 16 samples having counts at 55° C. in excess of 10,000 per ml., 10 had 37° C. counts of more than 300,000 per ml., while only 24 of the total of 121 samples had 37° C. counts in this range. Some tendency for high counts at 55° C. to be associated with high counts at 37° C. thus was indicated. The relatively low general level of thermophilic bacteria in ice cream may be associated with

TABLE 5

Relationship of plate counts at 37° and 55° C. on 121 samples of ice cream

Plate counts per ml. at 37° C.	No. of samples with 55° C. counts per ml. of						Totals
	Less than 1,000	1,000–3,000	3,100–10,000	10,100–30,000	31,000–100,000	101,000–300,000	
Less than 1,000	3	.....	1	.....	.....	.....	4
1,000–3,000	3	2	1	.....	.....	.....	6
3,100–10,000	16	4	5	1	1	.....	27
10,100–30,000	14	8	.....	.....	1	.....	23
31,000–100,000	16	3	4	2	.....	.....	25
101,000–300,000	10	.....	1	.....	1	.....	12
310,000–1,000,000	4	2	.....	1	3	.....	10
1,010,000–3,000,000	4	.....	.....	1	1	.....	6
3,100,000–10,000,000	1	1	1	1	1	1	6
More than 10,000,000	1	.....	.....	1	.....	.....	2
Totals	72	20	13	7	8	1	121

TABLE 6

Relationship of plate counts at 37° and 45° C. on 123 samples of ice cream

Plate counts per ml. at 37° C.	No. of samples with counts at 45° C. of									Totals
	Less than 1,000	1,000–3,000	3,100–10,000	10,100–30,000	31,000–100,000	101,000–300,000	310,000–1,000,000	1,010,000–3,000,000	3,100,000–10,000,000	
Less than 1,000	4	....	....	....	....	....	....	....	....	4
1,000–3,000	2	2	....	1	1	....	....	....	....	6
3,100–10,000	4	13	11	....	....	....	....	....	....	28
10,100–30,000	1	7	6	6	1	....	....	....	....	23
31,000–100,000	....	2	8	10	5	....	....	....	....	25
101,000–300,000	1	1	....	3	5	3	....	....	....	13
310,000–1,000,000	....	1	1	2	1	4	1	....	....	10
1,010,000–3,000,000	....	....	1	....	....	2	1	2	....	6
3,100,000–10,000,000	....	....	....	....	2	1	1	1	1	6
More than 10,000,000	....	....	....	....	....	....	1	1	....	2
Totals	12	26	29	22	15	10	4	4	1	123

the tendency for organisms of this type to die out at low temperatures, as has been demonstrated for milk (3, 6, 8).

The relationship of plate counts at 37° C. to those at 45° C. for 123 samples is shown in table 6. The data indicate a pronounced tendency for high counts at one temperature to be associated with high counts at the other temperature, with comparatively few exceptions to the general relationship. The conclusion seems justified that counts at 45° C. would not furnish sufficient additional information over that obtained from counts at 37° C. to justify the routine use of both temperatures.

DISCUSSION

Plate counts at 45° C. and 55° C. apparently furnish little information not obtained by plate counts at 37° C. on ice cream. In view of the known effect of low-temperature refrigeration on the counts of thermophilic bacteria in pasteurized milk, the comparatively small numbers of these organisms in ice cream of the type studied here are not unexpected. Routine detection in ice cream of organisms able to grow at 45° and 55° C. does not seem to be justified upon the basis of data obtained in this study.

CONCLUSIONS

1. The samples of ice cream examined contained few thermophilic bacteria.

2. Plate counts at 45° and 55° C. furnish little information in addition to that obtained with incubation at 37° C.

III. THE DIRECT MICROSCOPIC COUNT

Although Fabian (4) and Fay (5) outlined procedures for the direct microscopic method as applied to ice cream, neither of these investigators presented data concerning the quantitative significance of his results. Direct microscopic procedures for ice cream are presented in the seventh and eighth editions of Standard Methods for the Examination of Dairy Products (1, 2), with the notation that basis for quantitative interpretation is not available. The studies reported here attempt evaluation of the direct microscopic procedure for determination of bacteriological quality of ice cream.

METHODS

Preparations for direct microscopic counts were made by smearing 0.01 ml. of melted sample measured by capillary pipette over an area of 1 cm.^{2} The fixing and staining procedures outlined for ice cream in Standard Methods (1) were followed. Each individual cell was counted, using a microscope adjusted to give a factor of 600,000 and counting the number of fields designated by Standard Methods for the various count ranges.

TABLE 7

Relationship of 37° C. plate counts and direct microscopic counts on 117 samples of ice cream

Plate count per ml.	No. of samples with direct microscopic count per ml. of						Total samples
	Less than 100,000	100,000–300,000	310,000–1,000,000	1,010,000–3,000,000	3,100,000–10,000,000	More than 10,000,000	
Less than 1,000	1	3	.....	.....	.....	.....	4
1,000–3,000	5	1	.....	.....	.....	.....	6
3,100–10,000	17	6	4	.....	.....	1	28
10,100–30,000	13	2	6	1	.....	.....	22
31,000–100,000	13	5	3	2	.....	1	24
101,000–300,000	2	5	5	.....	.....	.....	12
301,000–1,000,000	1	1	4	.....	1	3	10
1,010,000–3,00,000	.....	.....	.....	2	1	2	5
3,100,000–10,000,000	.....	.....	.....	.....	1	4	5
More than 10,000,000	.....	.....	.....	.....	.....	1	1
Total samples	52	23	22	5	3	12	117

TABLE 8

Relationship of 45° C. plate count and direct microscopic count on 116 samples of ice cream

Plate count per ml.	No. of samples with direct microscopic count per ml. of						Total samples
	Less than 100,000	100,000–300,000	310,000–1,000,000	1,010,000–3,000,000	3,100,000–10,000,000	More than 10,000,000	
Less than 1,000	5	5	2	.....	.....	.....	12
1,000–3,000	17	4	6	.....	.....	1	28
3,100–10,000	17	3	3	2	.....	2	27
10,100–30,000	11	2	5	1	.....	1	20
31,000–100,000	3	6	2	.....	1	2	14
101,000–300,000	.....	2	4	1	.....	3	10
310,000–1,000,000	.....	.....	.....	.....	2	1	3
1,010,000–3,000,000	.....	.....	.....	1	.....	1	2
Total samples	53	22	22	5	3	11	116

RESULTS

The data in table 7 indicate a tendency for parallelism between plate and direct microscopic counts, with the microscopic counts tending to be of somewhat greater magnitude than the plate counts. The latter is not unexpected, since individual bacterial cells, rather than "sources," were counted. By using a standard of direct microscopic count less than 1,000,000 per ml., only 6 of 97 samples below this standard had plate counts above 300,000 per ml. and none of these exceeded 1,000,000 per ml. in plate count; only 5 of the 20 samples exceeding this direct microscopic count limit had plate counts below 300,000 per ml., and 2 of these had such excessively high direct microscopic counts as to indicate the probability the plate count was at fault in evaluating the sample. A standard based on a requirement of a direct microscopic cell count of less than 1,000,000 per ml. would not have provided entirely satisfactory separation under the conditions of this study, although a microscopic count standard at this level might have definite possibilities in segregating the majority of samples of excessively high plate count. Clump or "source" counts were not made, as counts of individual cells seemed more desirable from a fundamental standpoint.

The data in table 8 indicate less relationship between the direct microscopic count and the plate count at 45° C. than between the direct microscopic count and the plate count at 37° C. Especially notable is the number of samples with comparatively low plate counts at 45° C. which have high direct microscopic counts. Since plate counts at 45° C. on ice cream appear to have little or no significance beyond those at 37° C., the comparative lack of relationship at 45° C. between plate counts and direct microscopic counts would appear to be of little significance in the evaluation of the latter method.

The data in table 9 show an almost complete lack of relationship between the direct microscopic counts and plate counts at 55° C.

DISCUSSION

The ability of the direct microscopic method, counting individual cells, to detect most samples with high plate counts at 37° C. was demonstrated, as was its lessened usefulness in detecting organisms growing at 45° C. and its almost complete lack of suitability for detection of those bacteria favored by incubation at 55° C. Especially in view of the reportedly satisfactory use of the direct microscopic procedure for bacteriological control of pasteurized milk supplies in some areas (7, 9), the use of the method for control of certain types of ice cream supplies seems to be justified. The data do not indicate much possibility of use as a method of control of supplies on which low plate counts are the rule or for fine separation into several grades.

TABLE 9

Relationship of 55° C. plate count and direct microscopic count on 115 samples of ice cream

Plant count per ml.	No. of samples with direct microscopic count per ml. of						Total samples
	Less than 100,000	101,000–300,000	310,000–1,000,000	1,010,000–3,000,000	3,100,000–10,000,000	More than 10,000,000	
Less than 1,000	31	15	14	3	2	4	69
1,000–3,000	9	3	4	.....	.....	3	19
3,100–10,000	8	1	1	.....	1	1	12
10,100–30,000	2	2	.....	1	.....	2	7
31,000–100,000	2	2	1	1	.....	2	8
Total samples	52	23	20	5	3	12	115

CONCLUSION

The direct microscopic count of individual cells offers possibilities as a screen test for detecting the bacteriologically poorer samples of ice cream, as indicated by the plate count at 37° C.

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SULFUR COMPOUNDS AS DISINFECTING AGENTS FOR DAIRY EQUIPMENT*

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INTRODUCTION

Chlorine compounds have been the most widely used germicidal agents employed by dairy plants and creameries. Activities incident to the prosecution of the World War, however, have created demands for chlorine compounds so extensive that supplies available for domestic use are substantially limited. This limitation may well become more drastic as the war continues. Consequently, it is necessary, as well as desirable, to find substances that can be substituted for chlorine. It was the purpose of the present investigation to study the disinfecting properties of possible substitute germicidal agents.

Sulfur was formerly thought to be a valuable disinfectant, especially in the form of sulfur dioxide. In recent years, however, experiments have indicated that this compound has limited disinfecting value. It is used effectively as a fungicide and vermicide, but its only practical use as a bactericidal agent has been in preserving dried fruits, and in this case its effectiveness appears to be due to the increase of hydrogen-ion concentration resulting from the formation of sulfurous acid.

Although there appeared to be little probability that sulfur compounds would prove to be of value for sterilizing dairy equipment, it seemed to be logical and necessary to obtain information about them, because there has been some revival of interest in their use as germicidal agents for dairy equipment. This report, therefore, is concerned with a study of the germicidal properties of certain sulfur compounds to determine their suitability for use in dairy plants.

EXPERIMENTAL

Acid sulfites are of two types, the bisulfite and the pyrosulfite (meta bisulfite), the latter being the anhydride of the former. The pyrosulfites do not exist in solution, but they dissolve in water and ionize, yielding a cation and the anion, hydrogen sulfite, which is believed to undergo the following transformation:

$$2\,HSO_3 \longrightarrow SO_3 + H_2SO_3$$
$$H_2SO_3 \longrightarrow SO_2 + H_2O$$

Solutions of the sulfites gradually decompose with the separation of sulfur and the production of sulfuric acid. As sterilizing agents their solutions are too corrosive for practical use, so it was necessary to buffer them.

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In the work reported here, 5 per cent solutions of potassium pyrosulfite were buffered at pH 6, 7, 8, and 9. The buffer systems employed were as follows: Citric acid and sodium hydroxide at pH 6, trisodium phosphate at pH 7, and boric acid and trisodium phosphate at pH 8 and 9. On this basis the free sulfur dioxide produced amounted to 45 to 50 per cent of the weight

TABLE 1

Sterilizing properties and corrosive action of various sulfur compounds

Substance	Concentration used*	pH value	Survival of bacteria after varying periods of contact			Corrosive action on tin	
			5 min.	10 min.	15 min.	Loss (−) or gain (+) in weight	Remarks and general appearance
			%	%	%	%	
Potassium meta bisulfite	1.0%	4.5	5.0	4.0	5.0	—	Very corrosive immediately
"	1.0%	7.2	24.0	30.0	23.0	—	Sl. corrosive after 4 weeks
"	5.0%	6.0	12.0	10.0	12.0	6.68 −	Visible corrosion
"	5.0%	7.0	12.0	15.0	13.0	0.028 −	Not tarnished
"	5.0%	8.0	10.0	12.0	10.0	0.006 −	Not tarnished
"	5.0%	9.0	12.0	9.0	9.0	0.021 −	Not tarnished
"	10.0%	4.0	2.0	2.0	1.0	—	—
"	10.0%	7.2	27.0	29.0	35.0	—	—
Sulfur dioxide	1.4%	1.6	0.0	0.0	0.0	—	—
" "	2.8%	1.4	0.0	0.0	0.0	—	—
" "	5.6%	1.3	0.0	0.0	0.0	—	—
" "	11.0%	—	0.0	0.0	0.0	—	—
Acid sodium sulfite	1.0%	—	29.0	29.0	30.0	—	Visible corrosion
Sulfuric acid	—	1.4	0.08	0.08	—	—	Visible corrosion
H.T.H. 15	200 ppm. Cl		0.0	0.0	0.0	0.002 +	Not tarnished
Distilled water	—	6.4	—	—	—	0.015 +	Not tarnished

* Percentages are by weight.

NOTE: The dashes indicate that no determinations were made because, in comparison with weaker or less acid concentrations, results would be obvious. This statement does not apply to H.T.H. and distilled water.

of the pyrosulfite, which is equivalent to a 2.25 to 2.50 per cent solution of sulfur dioxide. In all analytical work, reagent grade sodium bisulfite of known sulfur dioxide content was used as a control.

When dairy equipment is being sterilized with chemical agents, the milk film that is likely to remain in and on the equipment may combine with the agent and then partially inactivate it. It is well known that many disinfectants, chlorine included, can be inactivated in this way. For that reason, milk was combined with the sulfur compounds employed. The milk also

provided a source of bacteria for testing the distinfectant properties of the compounds.

The sterilizing properties of the various solutions were determined by adding 2 ml. of raw milk to 48 ml. of the solution to be tested. Several different lots of raw milk were employed. Immediately after the milk was added, each container was shaken rapidly 25 times, each shake being an up-and-down excursion of about a foot. Proper dilutions were made, and 1 ml. quantities were plated after the milk had been in contact with the solution being tested for 5, 10, and 15 minutes. Standard tryptone-glucose-extract agar was used, and the plates were incubated for 48 hours at 37° C. The concentration of inoculum (ranging from 65,000 to 12,000,000 per ml.) was determined by adding 2 ml. of milk to 48 ml. of sterile distilled water and plating by the dilution method. A chlorine solution (H.T.H.) containing 200 ppm. of available chlorine served as a control. Milk was added and the same procedure employed as with the test solutions.

The corrosive properties of the sulfur compounds were tested on tinned copper strips of 1 inch by 2.5 inches dimensions. The metal strips were polished, washed, dried, and weighed, and then were immersed in 125 ml. of the various solutions, which were agitated at room temperature. After 16 hours, the metal strips were removed from the solution, rinsed with distilled water, dried, and reweighed to determine any loss or gain in weight. The general appearance of the metal strips was also noted to observe any obvious evidence of corrosion. In a few instances the solutions were not agitated, and the metal strips remained in the solutions at room temperature for four weeks.

The results of the bacteria counts and of the corrosion tests are shown in table 1. It should be noted that in all instances where the bacteria counts were reduced sufficiently to encourage the use of the agent, the pH values were quite low. (Although the pH value is not given for 11 per cent sulfur dioxide, it was unquestionably lower than for the other concentrations employed.) Thus, it would appear that any substantial disinfecting property displayed was due to increased hydrogen-ion concentration. Above pH 6, the percentage reduction of bacteria was not sufficient in any instance to justify recommending the use of any of the agents employed.

CONCLUSION

The results of the experiments here reported do not encourage the use of sulfur compounds for dairy plant sterilization.

LIVE-WEIGHT GAINS OF PASTURE-FED DAIRY HEIFERS

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It is well known that size of cow bears a close relation to milk-producing capacity. Large size is best obtained through programs of feeding and management which will produce rapid live-weight gains throughout the developmental period prior to first calving. While pasture feeding is one of the best ways of inducing good growth in heifers, pasture forage yields vary greatly from farm to farm, depending upon kind of pasture crop and fertility of the soil, and from month to month, or season to season, depending upon rainfall and temperature. The live-weight gains of heifers having access to pasture as the only feed are likely to follow the same trends as the pasture forage yields and may be positive or negative.

How much live-weight gain do dairy heifers make when pasture is the only source of feed? Do the dairy breeds differ in their ability to utilize pasture for growth? But few reports of experiments which supply answers to these questions are to be found in the literature. Bender and Bartlett (1) observed losses in weight of 40 to 100 pounds per head during the first month after fat two-year-old heifers were turned to pasture, while heifers winter-fed on roughage suffered no loss in weight and made greater total gains for the season. Eckles (2) made comparisons of the efficiency of Holstein and of Jersey heifers in the use of alfalfa hay only and a combination of alfalfa hay and corn silage for the making of winter live-weight gains. The Holsteins consumed more feed, made larger daily gains, and required less feed per pound of gain. Hayden (3) found that 29 Jersey heifers, one to two years of age, which were kept at pasture for 159 days, made daily gains for the year equivalent to 0.8 pound per head; while 22 Holstein heifers of the same age, which were pastured 151 days, made daily gains during the year amounting to 1.0 pound per head. Henderson and Anthony (4) reported daily live-weight gains of yearling dairy heifers kept at pasture from 194 to 203 days as ranging from 0.3 to 1.13 pounds per head. In a farm survey conducted by Misner (5), it was found that the gain in weight of heifers in 107 dairy herds, the majority of which were grade Holstein, amounted to 261 pounds during the period from 12 to 24 months of age. The heifers were pastured for approximately 169 days.

EXPERIMENTAL PROCEDURE

The records of 178 dairy heifers which had access to pastures, water, and salt as the only sources of feed during approximately five months of the year form the basis of the present study. The records covered the years 1936 to

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1943, inclusive. The ages at the beginning of the pasture season ranged from 8 to 24 months. None of the heifers calved or aborted while at pasture. They were turned to pasture in late April or early May, and kept on pasture until about October 1. In seasons of low rainfall (1937 and 1940) the pasture season was shortened, but in 1941 abundant rains made possible the use of pastures until the third week of October. The length of the pasture season ranged from 112 to 170 days. Scale weights were taken on three successive days just prior to turning to pasture and at 4-week intervals thereafter.

In 1936 and 1943, the heifers were pastured as one group, but in other years there were two or three groups of heifers employed in a comparison of different pasture crops. Differences also occurred in the number of heifers of each breed used in these comparisons. These differences are considered of too little importance to nullify or seriously impair the worth of the data as a basis for the present study since the heifers had essentially the same opportunities of obtaining ample amounts of feed. The experimental pastures were carefully managed and usually provided abundant forage.

DISCUSSION OF RESULTS

The average live-weight gains ranged from approximately two-thirds pound daily for the Brown Swiss heifers to approximately one pound daily for the Ayrshire, with an average of 0.84 pound per head daily for all heifers (table 1). Sometimes the rate of daily live-weight gain is used as the sole criterion of the results of feeding trials. On the basis of live-weight gains alone, it appears in the trial here discussed that the Ayrshires and Holsteins were superior to the other three breeds. There are other pertinent criteria, however, which should be given attention when evaluating such data. One of these is the daily gain in relation to the initial live weight. It is shown in table 1 that the Ayrshires, Guernseys, and Jerseys, made approximately the same live-weight daily gains when these are expressed as a percentage of the initial weights. These values are higher than those for the Brown Swiss and Holsteins.

A further criterion of the grazing ability of the breeds is the live-weight gain in relation to the amount of body weight maintained. The average of all scale weights for the season is assumed to be the amount of body weight maintained. The Holsteins maintained about 40 per cent more body weight and also made slightly larger daily gains than the Guernseys and Jerseys. This implies that the Holsteins consumed much more feed per head daily than heifers of the Guernsey and Jersey breeds. By the same reasoning, it is inferred that, with smaller amounts of pasture forage consumed and nearly as large daily gains per head made by the Guernseys and Jerseys, gains by these breeds were more economical. If the pastures were fully stocked, more Guernseys and Jerseys might be supported per acre of pasture, and the gains in live weight per acre would be larger.

A study was made of the variance of the daily gains of the heifers of each breed and the mean differences in daily gains of the five breeds. Using the F test as given by Snedecor (6) the calculated F value for the data is only 1.86, whereas values of 2.43 at the 5 per cent level, and 3.44 at the 1 per cent level, are required for significance. Applying the t test as stated by Snedecor, it is calculated that a difference of 0.437 pound would be required to show a significant difference in daily live-weight gains between any two of the breeds. It appears, therefore, that under the conditions of this trial,

TABLE 1

Live-weight gains of yearling dairy heifers with pasture as the only feed

	Average values per head				
	Ayrshire	Brown Swiss	Guernsey	Holstein	Jersey
Number of records	27	12	26	79	34
Age at beginning of pasture season, days	495	495	453	483	470
Live weight at beginning of pasture season, lbs.	696	823	565	832	564
Average live weight for entire pasture season, lbs.	771	882	623	891	625
Number of days on pasture	155	151	147	142	151
Total live-weight gain for season, lbs.	151	103	113	123	120
Live-weight gain daily, lbs.	0.97 ± 0.03	0.68 ± 0.05	0.77 ± 0.01	0.86 ± 0.03	0.80 ± 0.04
Standard error of mean	0.26 ± 0.02	0.23 ± 0.03	0.30 ± 0.03	0.38 ± 0.02	0.36 ± 0.03
Coefficient of variability of daily live-weight gains	26.95 ± 0.10	33.89 ± 0.67	39.62 ± 0.11	43.73 ± 0.06	36.67 ± 0.09
Daily live-weight gain as percentage of initial weight, lbs.	0.139	0.083	0.136	0.104	0.141
Relative amounts of live weight maintained	87	99	70	100	70

no significant differences were revealed in the inherent ability of these five breeds to make daily live-weight gains while pasture fed. This does not preclude the possibility that an experiment designed especially to study this point might reveal such differences.

SUMMARY AND CONCLUSIONS

Live-weight records of 178 pasture-fed yearling heifers of the Ayrshire, Brown Swiss, Guernsey, Holstein, and Jersey breeds made during the years 1936 to 1943, inclusive, show average daily live-weight gains for the entire group of 0.84 pound daily. Average daily live-weight gains for the breeds ranged from 0.701 pound for the Brown Swiss up to 0.963 pound for the

Ayrshire. In terms of percentage of the initial live weights, the average daily gains of the Ayrshires, Guernseys, and Jerseys were approximately the same and were somewhat higher than the corresponding values for the Brown Swiss and Holsteins. Statistical analyses of the variance of the live-weight gains indicate that in this trial no significant superiority of any breed to make live-weight gains while pasture fed was demonstrated.

Because of characteristic differences in body size, it is assumed that some breeds made live-weight gains with less pasture forage than others because of using less feed for maintenance. For example, the average daily live-weight gains of the Guernseys and Jerseys were nearly as large as those of the Holsteins, but the average live weight of the Guernseys and Jerseys was about 30 per cent less.

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THE USE OF UREA IN COMMERCIAL DAIRY FEEDS

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In November, 1943, a small amount of crystal urea was made available under allocation to feed manufacturers. Previous to that time most of the urea not used for the war industries was allocated to the fertilizer trade. For several years the experiment stations in the large dairy states have been getting urea for research use; and in 1941 the Association of American Feed Control Officials, foreseeing its feeding use, adopted a resolution accepting urea as an ingredient in proprietary cattle feeds.

Hart *et al.* (2), in 1939, studied the utilization of urea by growing calves. They found that the conversion of urea nitrogen to protein was limited and dependent on the total protein in the ration. Mills, Booth, Bohstedt and Hart (5) in 1942 found that the micro-organisms responsible for the use of non-protein nitrogen needed an available source of energy; that starch was more available as a source of energy than timothy hay. Rupel, Bohstedt and Hart (6) found that urea should not be fed at a rate greater than 1 per cent of the dry matter of the ration. This amounts to about 25 per cent urea nitrogen in the entire ration.

Loosli and McCay (4) found that calves as young as two months were able to grow on a ration containing about 75 per cent of the total nitrogen from urea. Johnson *et al.* (3) found that for sheep the biological value for urea was about 62.

Goss (1) gives a good discussion of the mechanism involved in converting urea to protein in the ruminant. He concludes that urea may replace part of the protein in basal diets containing insufficient protein to maintain nitrogen equilibrium, and adds that considerable work must be done before optimum conditions for the use of urea are understood.

Mills *et al.* (5) state "the effect of various ration constituents or the efficiency and rate of urea utilization should be thoroughly studied so that when and if urea becomes a practical nitrogen source for the farmer, urea-containing rations could be intelligently constructed to obtain the best results with as little waste as possible."

The protein shortage which developed in 1943 made it advisable to use urea before all the questions had been answered. The work reported here was undertaken in an effort to further the data on the use of urea as it is used in commercial dairy rations. The part of the work completed so far reports on the effect of urea on milk production, milk composition, palatability of feed and general health of the cow.

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Of the herds available to us for a feeding test, there was one that was outstanding. It consisted of about 30 registered Holsteins owned by a small local college. Last year, the third consecutive year on official test, the herd average was 437 pounds of butterfat and 12,933 pounds of milk. The herd is under the constant care of a dairy manager and has been free from tuberculosis, brucellosis and mastitis.

Seven cows in one section of the milking barn were chosen for the test group. It was judged unwise at that time to place more than this number on a ration that might give unfavorable results. The cows in this group were near the herd average in age and previous production, and had freshened between September and November, 1943. The rest of the herd received the control ration. Fifteen cows near the herd average of production and

TABLE 1

Dairy ration grain concentrate formulae

Ingredients	Control ration	Test ration						
		Nov.	Dec.	Jan.	Feb.	March	April	May
Corn meal	400	400	400	400	400			
Wheat bran	250	250	250	250	250			
Distillers' grain	400	400	400	400	300			
Corn gluten feed	350	200	100	.....	.....			
Crimped oats	200	200	200	200	200			
Yellow hominy	.....	310	400	490	580	Same	Same	Same
Crystal urea	.....	35	42	50	60			
Soybean oil meal	200	.....	.....	.....	.....			
Molasses	140	140	140	140	140			
Limestone	20	20	20	20	20			
Bonemeal	20	25	28	30	30			
Iodized salt	20	20	20	20	20			
Total	2000	2000	2000	2000	2000	2000	2000	2000

age, freshening between September and November, were chosen for record comparisons. The cows were milked twice a day and the milk weighed. All silage, hay and grain concentrates were weighed at each feeding.

Table 1 shows the formulae for the grain concentrate used in the test and control rations. The average chemical composition is 20.6 per cent protein, 4.5 per cent fat, 7.2 per cent fibre. The whole herd has been on the control ration since October, 1941. On November 1, 1943, the test group was given a mixture in which 35 lbs. urea, 310 lbs. homony and 5 lbs. bonemeal replaced 200 lbs. soybean oil meal and 150 lbs. corn gluten feed. This kept the levels of protein ($N \times 6.25$), fat, fibre and total digestible nutrients the same as in the original ration. In December, 100 pounds of corn gluten feed was omitted from the test ration; and 7 pounds urea, 3 pounds bonemeal and 90 pounds of hominy were added. On January 1, 1944, the entire 350 pounds of gluten feed was omitted, with urea and hominy feed making up the difference in protein and other nutrients. This made the non-protein nitrogen 36 per

cent of the total. On February 1, 100 pounds of distillers grains was omitted, with urea and hominy added to make the non-protein 43 per cent of the total. The test group has continued on this ration up to the present time.

UREASE ACTIVITY IN SILAGE

The feeding plan for this herd is quite common to most farms in this section of the country. Cattle are on pasture or in the "tramp" shed except during the milking period. In the early part of the afternoon, when most of the help is available, silage is weighed out and put into the manger. Then the grain concentrate is weighed out and placed on top of the silage. In the middle of the afternoon the cows come into the milking barn and to their stanchions. The question was raised as to whether urea in the grain concentrate would be stable during the one- or two-hour period in contact with the silage.

Samples of different silages were brought into the laboratory and tested for urease activity. Soybean, alfalfa and corn silages were put into jars with urea and kept under practical feeding conditions. Water was added to some of these samples. An aliquot portion was taken from the jars at intervals and tested for free ammonia. When water was added and the material incubated at 37° C., ammonia was detected in a few hours. However, it took several days at ordinary room temperature with the original moisture content of the silage before ammonia was evident in the samples.

PALATABILITY OF FEEDS

During the seven months that urea has been available for dairy feeds, we have had some complaints of feed refusal and digestive disorders among cows on urea-containing feeds. Each of these complaints was investigated with the thought in mind that urea might be causing this trouble. Each case, however, was due to some other condition. Sometimes in returning to the milking ration from a fitting ration the cows refused the feed and remained off feed even when presented with a ration not containing urea.

With the herd on test no trouble with palatability or off feed was experienced during the entire period. On a group of six cows the feed was changed overnight, and each time the test ration or the control ration was consumed with equal relish. It is a well-known fact that Holsteins are not as particular in their feeding habits as Guernseys or Jerseys. A herd of Guernseys receiving a commercial ration containing no molasses was tested for its reaction to urea. Three per cent urea was added to this dried ration and fed for four days. No cow in the herd showed any sign of refusing the feed.

MILK COMPOSITION

The butterfat content of the milk in the herd under consideration was tested each month by the official tester for the Dairy Herd Improvement

TABLE 2

Monthly record of milk production and butterfat percentage

	October		November		December		January		February		March		April		May	
	Milk	Fat	Milk	Fat	Milk	Fat	Milk	Fat	Milk	Fat	Milk	Fat	Milk	Fat	Milk	Fat
	lbs.	%	*lbs.*	%	*lbs.*	%	*lbs.*	%	*lbs.*	%	*lbs.*	%	*lbs.*	%	*lbs.*	%
Harvel	32	3.7	40	3.6	37	3.6	31	3.2	30	3.0	27	3.4	27	3.0	28	3.3
Henny	43	3.2	43	3.4	39	2.9	35	2.9	34	3.0	33	2.9	31	2.9	35	2.9
Heath	40	3.8	53	3.4	51	3.7	44	3.2	41	3.1	37	3.2	35	2.9	29	3.5
Hara	39	2.9	37	3.5	31	3.3	28	3.5	24	3.2	23	3.3	23	2.8	23	3.9
Harley	43	3.6	44	2.9	40	3.1	35	3.6	33	3.7	28	3.5	24	3.6	19	3.0
Hue	Dry	.....	Dry	.....	51	3.0	53	3.0	51	2.9	46	3.2	46	2.8	45	3.6
Heaton	46	3.1	43	3.0	39	3.2	35	3.1	32	3.3	29	3.1	28	3.2	25	4.4
Average	40.5	3.3	43	3.3	41	3.3	38	3.2	35	3.2	32	3.2	31	3.2	29	3.5
Hofer	39	3.3	37	3.5	35	3.6	32	3.4	29	4.0	27	4.0	29	3.9	27	3.7
Hat	53	3.8	48	3.6	42	3.5	39	3.2	37	3.2	34	3.2	32	3.5	28	3.1
Hackle	Dry	.....	41	3.7	52	3.6	50	3.3	46	3.7	38	3.1	41	2.7	38	3.5
Hab	Dry	.....	54	4.0	52	3.7	47	3.3	44	3.4	43	3.4	43	3.3	39	4.0
Hoylton	Dry	.....	Dry	.....	59	3.3	55	3.0	51	3.2	48	3.0	45	2.9	46	3.2
Helmar	Dry	.....	Dry	.....	34	3.3	33	3.0	29	3.2	26	3.1	25	3.0	24	3.1
Huckerk	36	3.0	39	3.1	35	3.2	32	3.2	30	3.1	28	3.2	29	2.7	28	3.6
Helag	40	3.3	40	3.7	35	3.5	34	3.4	34	3.4	23	3.8	33	3.3	32	3.6
Hattag	37	4.2	37	3.6	35	3.0	31	3.1	30	3.3	28	3.4	27	3.0	26	3.7
Harlag	Dry	.....	Dry	.....	31	3.9	30	3.7	29	3.5	28	3.6	27	3.4	29	3.1
Hamill	38	3.2	40	3.3	34	3.2	32	3.4	32	3.3	31	3.7	34	3.2	34	3.5
Helama	31	3.1	28	3.4	25	3.0	23	3.1	21	2.7	20	3.0	20	3.7	16	4.3
Henning	37	3.4	35	3.3	27	3.8	26	3.3	24	3.9	19	3.8	18	3.3	18	4.1
Hika	45	3.0	44	3.6	39	3.8	34	3.8	30	3.5	27	4.0	26	3.5	25	3.1
Heart	48	3.1	48	2.9	42	3.1	34	3.0	38	3.1	34	3.0	32	2.8	28	3.7
Average	40.4	3.4	41	3.3	39	3.4	36	3.3	34	3.4	31	3.4	31	3.3	29	3.6

Association. The percentage of butterfat in the test group averaged 3.3 per cent during the test period. The percentage of butterfat in the control group averaged 3.4 per cent.

Three times during the test period protein tests were made on milk taken from the different groups. Each time the average milk protein in the test group was slightly higher than that in the control group, although individual tests varied by more than this difference. The overall average for milk protein in the test group was 3.2 per cent, with that of the control group 3.0 per cent.

MILK PRODUCTION

The cows were milked twice a day and each milking was weighed to the nearest tenth of a pound. Average production for each cow during each month of the test is tabulated in table 2. The average per cow for the test group and the control group is very nearly the same for each month over the test period. The average for the seven months is 36 pounds per day for the test group and 35 pounds for the control group.

DISCUSSION

There is not much question that, over the short period of this test, urea can be used in dairy rations to replace part of the natural protein without unfavorable results. Milk production has been maintained in the test group at a level equal to that in the control group. Milk fat and milk protein in the test group agree with that in the control group within the limits of probable error. The results have been summarized in table 3.

TABLE 3

Average daily milk production, milk composition and feed consumption on the test and control rations

	Test ration	Control ration
Number of cows fed	7	15
Number of days in period	210	210
Daily feed, pounds		
Concentrates	10.8	10.5
Hay	10.0	10.0
Silage	21.4	21.4
Daily milk, pounds	36.0	35.0
Per cent of fat	3.3	3.4
Per cent of protein	3.2	3.0
Weight, pounds—April	1443	1382
June	1471	1411
Gain	28	29

We do not know yet what these results may be over a longer period of time. The feeding requirements at a given level of production can be calculated. For example, the cows on test producing an average of 36

pounds of milk a day, with an average protein content of 3.2 per cent, would need 1.15 pounds of protein. Add to this the protein requirement for maintenance, which is 0.9 pounds a day for cows of this weight, and you get a total daily requirement of 2.05 pounds of protein. By using Morrison's figures of protein digestibility, these cows received 2.3 pounds of digestible protein a day. However, if urea were not available as a source of protein or if the protein intake per day were figured without urea, each cow would receive 1.6 pounds a day digestible protein. This would leave the cow deficient to the extent of about 0.5 pound protein a day. It would not take long at this level for the cow to show some evidence of deficiency, either in decreased production or in loss of weight. Of course, the accepted figures for maintenance over a short period may be considerably lower than now estimated, but it would have to go down to 0.3 pound digestible protein a day per 1000 pounds weight, before this deficiency would be corrected.

One of the cows in the test group aborted a five-month-old fetus. The reason for this could not be determined. A veterinarian's report on the herd showed normal embryonic development and weight[1] between April and June. The cows in each group had maintained milk production and gained an average of 28 pounds during these two months.

The whole herd on test did not give as good results as the previous years' records would indicate. One reason for this is that the cows were milked only twice a day, whereas three milkings per day had been the practice in past years. Another reason may be the low quality of hay available. The alfalfa stand had been overrun with orchard grass, giving the hay a high fibre content and a lower T.D.N. value. These tests are continuing and will include records from all the cows in the herd, some of which have production figures of 23,000 pounds a year.

SUMMARY

1. Urease activity was observed in all silage samples tested; but under average conditions of time, temperature, and moisture there was no practical destruction of urea when added to a dairy ration and placed over the silage in the manger.

2. No condition of unpalatability or digestive disorder in any commercial or test ration containing urea could be traced to the use of this ingredient.

3. The percentage of butterfat and protein in the test group and in the control group did not differ significantly.

4. Milk production during the first seven months of lactation was the same in the test group as in the control group.

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[1] Weight was estimated by means of the chest measure.

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ABSTRACTS OF LITERATURE

BOOK REVIEWS

387. Annual Review of Biochemistry. Volume 13. Published by Annual Reviews, Inc., Stanford University P. O., Calif. 27 sections including indexes. 795 pages. $5.00.

As in previous volumes, *Annual Review of Biochemistry* is the handbook whereby competent authors have the opportunity to review the recent developments in selected fields of biochemistry. The subjects of discussion and the authors are selected by an editorial board. In each of the reviews, the authors appraise, as well as review, the developments. Milk, being biologically complex, is related directly or indirectly to many of the subjects of discussion in Annual Reviews. Of the discussions of direct interest to those engaged in dairy research may be cited the following: Biological Oxidations and Reductions; Non-Oxidative Enzymes; Chemistry of: The Carbohydrates; the Lipids, the Proteins and Amino Acids. Metabolism of: Carbohydrate; Fat; Proteins and Amino Acids. Mineral Metabolism; Water and Fat Soluble Vitamins; Nutrition; Nutritional Deficiencies of Farm Animals (by Huffman and Duncan of Michigan State College). Other sections are reviews on Steroids, Biochemistry of Nucleic Acids, Purines, and Pyrimidines, Chemistry of Hormones, Biochemistry of Malignant Tissue, Alkaloids, Synthetic Drugs (Antispasmodics), Photo-Periodism in Plants, Chloroplast Pigments, Mineral Nutrition of Plants, Growth Regulating Substances in Plants, Biochemistry of Fungi, and Histochemistry. Annual Reviews is definitely the tool of the trained research worker, written in condensed, technical style. K.G.W.

BACTERIOLOGY

388. The Rapid Identification of Mucoid Hemolytic Streptococci of Possible Epidemic Origin. Major Isadore Pilot, M.C., A.U.S. Amer. Med. Assoc. Jour., *125*, No. 15: 1037. Aug. 12, 1944.

A medium is described for the rapid isolation of mucoid strains of beta hemolytic streptococci (*Streptococcus epidemicus*) associated with milk-borne epidemics of sore throat and scarlet fever. Ascites fluid infusion blood agar has been used, but ascites fluid is not always available. Difco dehydrated brain heart infusion prepared with 1.75 per cent agar furnished a satisfactory base for moist plates with 5 per cent human blood added. In 12 to 24 hours, colonies appear large, mucoid, ameboid and confluent. Infusion agar prepared with various peptones failed to bring out the large mucoid growth. Isolation is followed by grouping and typing of the cultures.

Of recently reported milk-borne outbreaks of sore throat and scarlet fever, now traced to serologically specific types of hemolytic streptococci, type 3 accounted for three outbreaks, types 2 and 17 for others. These types appear to be sources of epidemic strains, but no mention is made of any mucoid property.

"The mucoid strains are particularly responsible for the bovine mastitis which is the source of epidemic milk-borne septic sore throat and scarlet fever. Experimentally, the mucoid strains ascend into the udder by simply smearing the teat and cause a similar mastitis. This aggressive property of the mucoid strains is further demonstrated by the frequency of their occurrence in otitis media, mastoiditis and meningitis complicating sore throat." D.P.G.

BUTTER

389. Importance of Copper in Certain Color Changes in Butter. R. V. Hussong and B. W. Hammer, Res. Lab., Sugar Creek Creamery Co., Danville, Ill. Food Res., *9*, No. 4: 289. July–Aug., 1944.

Additional evidence is presented of the ability of copper contamination of cream to cause bleaching of butter accompanied by tallowy flavor; also, evidence that copper contamination of wrappers, even in isolated spots, may initiate bleaching and off-flavor, which will start adjacent to the spot and eventually spread to areas of the butter not contaminated with copper. The fact that, even when the butter is uniformly contaminated with copper, the bleaching begins at the surface is evidence of the importance of air as an accelerating agent in the reaction. F.J.D.

CHEESE

390. Some Factors Affecting the Behavior of Cheddar Cheese in Cooking. Catherine Personius, Edith Boardman, and Andrianna R. Ausherman, Dept. of Home Econ., Univ. of Wis., Madison, Wis. Food Res., *9*, No. 4: 304. July–Aug., 1944.

The authors present evidence indicating that Cheddar cheese improves in cooking quality with curing, the improvement being more rapid in cheese of high moisture content and in the case of curd cured in hermetically sealed cans as compared with daisies. The soluble protein of the cheese also increases with age, but there is no definite relationship between this factor and cooking quality. Low fat cheeses have poor cooking quality.

The blending of cheese with liquids is affected by the pH and ion content of the liquid. At pH 5.8 and over, good dispersion is obtained. At pH 4.0 to 5.0, the cheese tends to separate from the liquid in hard curd-like particles. High temperatures employed in preparation of cheese mixtures intensify the tendency of the cheese to mat, string, become tough and separate fat. F.J.D.

391. **Salt Migration in Cheddar Cheese Curd and Its Effect on Moisture Content, pH and Bacterial Content.** W. H. HOECKER AND B. W. HAMMER, Iowa Agr. Expt. Sta., Ames, Iowa. Food Res., *9*, No. 4: 278. July–Aug., 1944.

This study shows that cheese loses moisture rapidly at the surface of individual curd particles and in the interior of the particles during the first 15 hours of pressing. The greatest loss is at the surface. Losses after 15 hours are relatively small. The salt content of cheese is relatively high at the particle surface, at hooping time, and relatively low in the centers. During pressing, the salt decreases at the surface and increases at the center; and 24 hours after pressing, it is usually quite uniform throughout the particle. At milling, the pH values are essentially the same at the surface and the center of the unsalted curd particles. When hooped, the surface values are slightly higher and the values at the center slightly lower. During pressing, values at both places fall rapidly and gradually approach each other, until at 24 hours after pressing they are about equal. Changes in bacterial counts were not sufficiently definite in the study to be conclusive.

In Cheddar cheese ripened four months, the distribution of moisture and salt was found to be fairly uniform. F.J.D.

CHEMISTRY

392. **Human-Milk Fat. 1. Component Fatty Acids.** T. P. HILDITCH AND M. L. MEARA, Dept. of Indus. Chem., Univ. of Liverpool, England. Biochem. Jour., *38*, No. 1: 29–34. 1944.

A limited amount of early and late lactation human-milk fat and a larger amount of saponified human-milk fat were analyzed by ester-fractionation to determine the various fatty acids contained therein.

Their results show there is about an equal amount of saturated and unsaturated fatty acids in human-milk fat. Compared with cow-milk fat, it contains a relatively smaller percentage of the lower molecular weight fatty acids and a much larger percentage of the 18-carbon unsaturated fatty acid, this being unusually high for an animal fat. "Human-milk fat, in regard to its component acids, has more resemblance to a typical margarine fat-blend than to butterfat." A.O.C.

393. **Adsorption of Riboflavin by Lactose. Influence of Temperature.** ABRAHAM LEVITON, Bur. of Dairy Indus., U. S. Dept. Agr., Washington, D. C. Indus. and Engin. Chem., Indus. Ed., *36*, No. 8: 744. Aug., 1944.

This work follows an earlier paper on the influence of concentration. A knowledge of the influence of temperature furnishes a basis for the production of adsorbates (milk sugar containing adsorbed riboflavin) as by-products in the manufacture of lactose. To utilize the productive capacity

of milk sugar plants for the manufacture of adsorbates, it is necessary to establish conditions for the controlled preparation of these adsorbates. The range of concentrations and temperatures studied include those which would be encountered in the manufacture of adsorbates from grain curd casein whey and are applicable to a wide range of operating conditions. In the commercial manufacture of lactose, even if all the riboflavin present in whey were adsorbed, a weak adsorbate would be obtained because the ratio between the quantity of lactose crystallizing from whey and the quantity of riboflavin in the whey is large. There is a critical riboflavin concentration beyond which the degree of adsorption rises sharply and increases linearly at 5° and 28° C. with increasing concentration. The data are considered primarily from the standpoint of their practical application, but a number of problems of both theoretical and practical interest are discussed. B.H.W.

394. Composition of Casein in Milk. G. A. RAMSDELL AND E. O. WHITTIER, Div. of Dairy Res. Labs., Bur. of Dairy Indus., Agr. Res. Admin., U.S.D.A., Washington, D. C. Jour. Biol. Chem., *154*, No. 2: 413–419. 1944.

Heretofore the analyses reported for casein have been on the basis of the acid-precipitated product. The authors have employed a new method to separate the calcium caseinate—calcium phosphate complex from milk—by means of a supercentrifuge.

"In the literature there is no analysis of the elementary composition of casein obtained by our procedure, and that the results check, as a whole, surprisingly well with analyses of casein obtained by acid precipitation is interesting evidence that the changes in physical character through the action of acid are not accompanied by a pronounced alteration in its percentage elemental composition. However, the fact that the percentages we found for sulfur and phosphorous are somewhat higher than those obtained for casein repeatedly dissolved by alkali and precipitated by acid indicates that such treatment removes a portion of these elements from casein."

The authors report the complex containing 4.80% tricalcium phosphate and 95.20% calcium caseinate; and this calcium caseinate having the following percentage composition: Calcium 1.18, Phosphorus 0.78, Nitrogen 15.34, Carbon 52.29, Hydrogen 6.919, Sulfur 0.762, and Oxygen (by difference) 22.73. A.O.C.

CONCENTRATED AND DRY MILK; BY-PRODUCTS

395. Evaporated Milk. Current Comment. ANONYMOUS. Amer. Med. Assoc. Jour., *125*, No. 12: 852. July 22, 1944.

Physicians are urged to avoid prescribing evaporated milk by named brands. Reference is made to a survey of the distribution of evaporated

milk in which it was shown that the shortage proved to be not a shortage of evaporated milk but of certain favorite brands. Less-well-known brands were available but not moving. Instead of advising against changing brands, physicians can do a service to their patients and their country by explaining to mothers that all brands of evaporated milk must meet federal standards. If the favorite or accustomed brand is not available, satisfactory results can be expected from the use of less familiar brands, provided consideration is given to whether the milk selected is irradiated or fortified with vitamin D. If the milk selected is not so fortified, supplementation of the diet or formula with this vitamin can be made separately. D.P.G.

396. Retardation of Fat Autoxidation in Dried Milks. M. B. Williamson, Res. Labs., S.M.A. Corp., Chagrin Falls, Ohio. Food Res., *9*, No. 4: 298. July–Aug., 1944.

Several antioxidants, rice bran concentrate, Avenex, tocopherols, hydroxyquinone monobenzyl ether and 4,4-dehydroxydiphenyl ether, tested for their potency on mixed fats, were found to be effective when the fats were incorporated into skim milk powder. Thiourea, normally without effect in protecting fats, showed antioxygenic powers for fats combined with skim milk in the dry form. The authors show this to be due to the presence of water and discuss the theory of this action. F.J.D.

DISEASE

397. Lactic Acid: A Corrosive Poison. E. Gordon Young and Ralph P. Smith, Depts. of Biochem. and Path., Dalhousie Univ., Halifax, N.S. Amer. Med. Assoc. Jour., *125*, No. 17: 1179–1181. Aug. 26, 1944. D.P.G.

398. Mastitis. E. C. McCulloch, A. A. Spielman and O. J. Hill. State Col. of Wash. Ext. Cir. 75. 4 pages. April, 1944.

A brief summary depicting, by means of cartoons and diagrams, the causes, spread, prevention, and control of mastitis. J.G.A.

FEEDS AND FEEDING

399. Vitamins D and A in Alfalfa Hay. G. C. Wallis. South Dakota Agr. Expt. Sta. Cir. 53. 12 pages. June, 1944.

Vitamin D develops as rapidly in small windrows as in the swath. Less vitamin D develops in large windrows than in the swath and small windrows, and still less in cocks. Most of the increase in cocks takes place in the outside layers.

Carotene losses are much less from the windrow than from the swath. Losses are still less from cocks.

Allowing the hay to wilt in the swath for a few hours and then raking it into small to medium sized windrows provides for rapid drying of the hay, encourages the development of as much vitamin D as the particular plants are capable of producing, and conserves a fair amount of carotene.

Finishing the curing in cocks after partial drying in the swath and windrow tends to conserve more of the carotene but takes more time and labor and provides less vitamin D.

Turning the windrows for the last half day or full day of curing increases the vitamin D content by about 100 International Units per pound as compared with unturned windrows.

The development of vitamin D in alfalfa hay by sunshine exposure is a comparatively slow process which continues gradually over a period of at least 6 or 8 days. The vitamin D content of hay could be increased by continuing the curing beyond the length of time necessary for proper drying, but the losses in carotene and other valuable properties would more than offset the gains.

Alfalfa hay probably varies between 300 and 1,000 International Units of vitamin D per pound, averaging about 500 to 600 units.

Alfalfa varies from time to time in the amount and rate of vitamin D development induced by sunshine exposure. The reasons for such variations are not known. J.G.A.

400. The Intensity of Feeding as Related to Milk Production. T. A. Baker and A. E. Tomhave. Del. Agr. Expt. Sta. Bul. 248. 15 pages. June, 1944.

Five groups of Holstein cows were fed maintenance rations plus allowances of total digestible nutrients for milk production equal to 82.2, 105.3, 122.4, and 131 per cent of the Haecker standard, respectively. Substantial increases in production were obtained by feeding in excess of the Haecker standard. The amount of milk produced for each pound of total digestible nutrients fed was greatest at the lowest feeding level. The addition of a pound of nutrients produced the same increase in milk production at each higher level. For the most profitable milk production it can be conservatively recommended that the allowance of total digestible nutrients prescribed by the Haecker standard be increased by at least 20 per cent unless the cost of each added pound of total digestible nutrients is as great as the net cash return from 1.46 pounds of milk containing 4 per cent butterfat. Feeding digestible nutrients at different levels had no effect on the body weight or condition of the cows. There was no effect of feeding at different levels on butterfat percentage. J.G.A.

401. Feeding Peanut Meal and Hay. W. J. SHEELY, R. B. BECKER, N. R. MEHRHOF, AND H. L. BROWN. Fla. Agr. Ext. Serv. Bul. 115. 15 pages, illus.

Detailed information on the composition of these Florida-grown products, together with specific directions for feeding them to beef cattle, dairy cattle, swine, and poultry. J.G.A.

402. Carotene Content of Alfalfa. Retention on Dehydration and Storage. RALPH E. SILKER, W. G. SCHRENK, AND H. H. KING, Kans. Agr. Expt. Sta., Manhattan, Kans. Indus. and Engin. Chem., Indus. Ed., *36*, No. 9: 831. Sept., 1944.

The effect of blanching, grinding, storage temperature and chemicals upon the stability of carotene in alfalfa was studied. Blanching the fresh alfalfa with steam prior to drying, thereby inactivating the enzymes, furnished complete protection for the carotene during the dehydration process. The grinding of fresh alfalfa caused a loss of carotene. The addition of a suitable antioxidant or addition of a chemical which was known to suppress enzyme activity furnished partial protection for the carotene during the dehydration. Diphenylamine and hydroquinone were the most effective antioxidants while thiourea and sodium cyanide helped to inactivate enzymes. The carotene content of alfalfa meal decreased as the temperature of storage increased. Storage at 3° C. of blanched and dehydrated alfalfa protected the carotene for long periods. There was a loss when the meal was removed from cold storage and allowed to stand at higher temperatures. B.H.W.

FOOD VALUE OF DAIRY PRODUCTS

403. Riboflavin Content of Milk and Milk Products. LOUISE DANIEL AND L. C. NORRIS, School of Nutr., Cornell Univ., Ithaca, N. Y. Food Res., *9*, No. 4: 312. July–Aug., 1944.

Modified fluorometric and microbiological methods for determining the riboflavin content of 18 different dairy products were found to give results without significant differences, but on the whole somewhat lower than values reported in the literature where rat-assay methods were employed.

Average riboflavin values on the fresh basis for the products studied are presented in μg./gm. as follows: dried sweet cream buttermilk, 33.65; dried whey, 20.72; dried skim milk, spray process, 19.81, roller process, 18.81; dried whole milk, spray process, 15.44; roller process, 14.76; Cheddar cheese, 3.00; cream cheese, 1.87; liquid wholemilk, 1.77; liquid skim milk, 1.58; liquid buttermilk (cultured), 1.56; light cream, 1.47; liquid whey, 1.24; and butter, 0.367. F.J.D.

ICE CREAM

404. General Points in the Handling of Sherbets. B. I. MASUROVSKY, Res. Editor. Ice Cream Trade Jour., *40*, No. 8: 48. Aug., 1944.

Successful merchandising of bulk sherbets presents several problems. Consumers should not be forced to accept sherbets in place of, or in order to get, ice cream. Sherbets have been most popular when sold in factory-filled packages in combination with ice cream and in the form of novelties such as chocolate flavored "pop" containing milk sherbet. Strawberry, red raspberry, black raspberry, orange or pineapple "pops" have been popular. Vanilla, chocolate and other important ice cream flavors should not be used as sherbets in order to avoid confusion, or the possible substitution by ice cream dealers, or at the soda fountain. At least 20% of pure fruit material should be added to fruit ices and sherbets which are frozen with agitation. "Pops" and frozen confections are frozen without agitation. Overrun should be limited to not more than 40% for "pops" and not more than 50% for sherbets. Attention should also be given to sanitation. Care and attention in the production of high-quality sherbets now should aid in planning for postwar sales. W.H.M.

405. Mocha Flavor and Its Place in Ice Cream. B. I. MASUROVSKY, Res. Editor. Ice Cream Trade Jour., *40*, No. 9: 52. Sept., 1944.

Mocha is a flavor created by a combination of chocolate and coffee. These two flavors may be added to the ice cream mix in extract form, or coffee extract may be added to a mild chocolate ice cream mix. If coffee is added to a chocolate mix, only about half the usual amount of chocolate ingredients should be present. The amount of coffee extract to use will vary from ½ to 1 ounce per gallon of ice cream mix. It should be free from chicory or other foreign flavoring material. Other points which should be observed in making Mocha-flavored ice cream are: (1) the sugar content should be less than that of chocolate ice cream or about the same as for vanilla ice cream. (2) The mix should contain no cereals or substitutes for milk solids. (3) It is desirable to increase the fat content 1 or 2 per cent above that of the standard vanilla mix.

Mocha and vanilla ice cream make a nice two-layer brick. Other recommended combinations are orange or strawberry sherbet, red raspberry sherbet and peach ice cream. When served at the fountain, Mocha ice cream should be topped with nuts and marshmallow rather than with chocolate sauce. In advertising the ice cream, the emphasis should be put on chocolate Mocha rather than coffee Mocha. W.H.M.

MILK

406. Statistical Aspects of the Acidity Test. H. BARKWORTH. Dairy Indus., *9*, No. 1: 20. Jan., 1944.

The author points out the importance of controlling the amount of phenolphthalein used in the acidity test as this factor has been shown to have a greater effect on the result than any other single factor. The fact that the relationship is linear means that a given change in the amount of indicator will always cause the same amount of change of pH of the endpoint. By increasing the concentration of indicator from $\log_{10}$ 1.6990 (50 mmgms. per 100 ml. milk) to $\log_{10}$ 1.9031 (80 mmgms.) lowers the pH of the endpoint from 8.39 to 8.34. Similar changes in concentration will give corresponding changes in the pH of the endpoint. The correlation coefficient is large and therefore indicates a very close relationship between these two factors. D.V.J.

407. Effect of High Cell Content on Resazurin and Methylene Blue Tests. C. S. MORRIS AND M. EDWARDS. Dairy Indus., *9*, No. 2: 92. Feb., 1944.

It was found that the inclusion of high-cell-content milk into good quality bulk milk did not materially affect the results of the "Ten-Minute" Resazurin Test. However, in some cases when such milk was subjected to the Standard Routine Resazurin Test, a definite effect was noted so that the milk might be placed in the B or C categories. In some cases the addition of 5 per cent of high-cell-count milk to good quality, low-cell-count milk was sufficient to cause a noticeable change in the test.

The Methylene Blue Test was also found to be affected by the presence of high cell content milk in otherwise good quality milk. As little as 15 per cent of high-cell-count milk (from cows with no clinical symptoms of mastitis) can be sufficient for a failure on the Methylene Blue Test.

In some cases high-cell-count milk has the same resazurin reduction time as milk of normal cell content. In the majority of these cases, the cells present were mainly tissue cells.

The author points out that this work is only preliminary and in many ways incomplete. D.V.J.

408. Influence of Udder Cells on the Routine Resazurin Test, the Ten-Minute Resazurin Test and the Methylene Blue Test. S. B. THOMAS AND D. A. BOWIE. Dairy Indus., *9*, No. 5: 335. May, 1944.

Approximately 5,000 bulk herd samples were examined over a period of three years. Seventy per cent of the samples had cellular counts under

750,000 per ml., while 20 per cent had counts between 750,000 and 1,500,000. Eight per cent of the samples contained over 1,500,000 cells per ml.

Normal milk from herds with a low incidence of mastitis and counts under 750,000 cells per ml. were not degraded to categories B or C in the routine resazurin classification. Leucocyte activity alone was found responsible for the degradation to category B of 25 per cent of the samples with cell counts between 750,000 and 1,500,000. Milk infected with mastitis or containing a high proportion of late lactation milk was usually detected by the routine resazurin test. Sixty-five per cent of the samples containing over 1,500,000 cells per ml. were degraded to category B and 10 per cent to category C. Twenty-five per cent of these samples reduced methylene blue within 5½ hours. D.V.J.

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ERRATA

Vol. XXVI, No. 12, page A228

The first sentence in abstract 532 should read: "This investigation deals with the vacreator, a vacuum pasteurizer for cream for butter making, developed in New Zealand."

Vol. XXVII, No. 3, page A35

Line 11 in abstract 70 should read: "The phage infection usually occurs from the 'whey fog' from a whey separator, ..."

Vol. XXVII, No. 4, page A70, line 15

Conclusion 6 should read: "It cannot be safely assumed: . . . ."

Vol. XXVII, No. 8, page 673

The last line in the first paragraph should read: ". . . 34.0–49.0 μg. protein and 0.57–0.86 μg. lipide phosphorus were adsorbed per . . . ."

Vol. XXVII, No. 10, pages 851, 853 and 855

Running headlines should read: "VITAMINS IN SUMMER MILK."

Vol. XXVII, No. 10, pages 850 and 854

Running headlines should read: "ARTHUR D. HOLMES ET AL."

Vol. XXVII, No. 10, page 812

Table 1, column 3: 0.151 should read 0.0151.

51%

Return on the Investment

The words "reconversion" and "post-war planning" have been used so much in recent months that there is a tendency to try to avoid the terms. But that is just a self-conscious effort to be original. The fact is that for the good of the nation the biggest job before every individual, every group, every business, every industry, is to plan so well that the reconversion period will be so short that the national income will be maintained without a slump.

If the job is done well it will result in full employment and a steady forward march of the traditional American high standards of living.

There might be differences of opinion on overall plans. But there is agreement that one of the most powerful contributions will be made by each business and each industry seeing its own problems in a clear light—and going to work on them. *When each soldier takes one step forward, the whole army advances!*

The dairy industry is working in that direction. The idea of setting its sights on the "Two Billion Gallon Ice Cream Year" is the kind of thinking the nation needs. The next step is to lay the groundwork for that goal. And that is where vanilla comes in for special attention!

As with everything else, ice cream volume will increase only if the product offered to the consumer increases in appeal and satisfaction. One of the first considerations in that appeal is flavor. *Flavor makes sales!*

And so, it is highly important to remember which flavor should receive the greatest study, research and promotion.

The 1938 study of ice cream flavor-preference, made by the International Association of Ice Cream Manufacturers, revealed that vanilla accounted for 51.26% of all the ice cream volume—more than the other 147 flavors put together.

Therefore any investment in study or research that improves the vanilla ice cream of a manufacturer will have a good effect on more than 50% of his gallonage. It is a case of fifty-one per cent return on the investment.

* * *

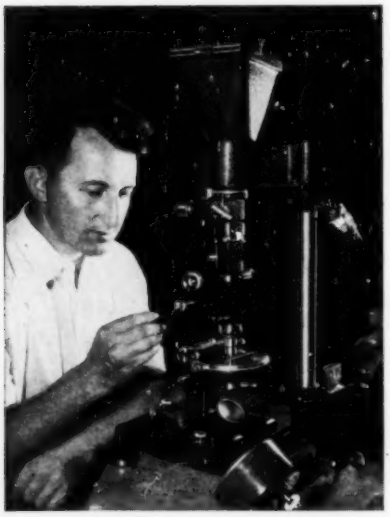
David Michael & Co., with its half century of experience in specializing on vanilla flavoring and the perfection of Mixevan, is at your service to assist you in developing a finer vanilla ice cream.

Mixevan—"America's Flavorite"
and other powdered vanilla products

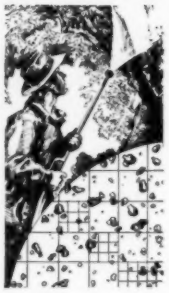
DAVID MICHAEL & CO.

half a century in the flavoring field

Front and Master Streets, Philadelphia 22, Pa.



Microscopes and Agriculture



Agriculture, one of our oldest sciences, benefits constantly from scientific investigation and quality control.

The Spencer Microscope shown above, equipped for photomicrography, is in use in the Eastern States Milling Corporation, Buffalo Plant. Photomicrographs of wettable sulphur particles used in agricultural sprays help to establish and maintain a high standard in the finished material. Sprays are among the diversified products for farm use handled by Eastern States Farmers' Exchange.

For literature on Spencer Microscopes and other scientific instruments, write to Department M28.

ARMY E NAVY

Spencer LENS COMPANY
BUFFALO, NEW YORK
SCIENTIFIC INSTRUMENT DIVISION OF
AMERICAN OPTICAL COMPANY

D-LUXE

LEAVES NO "FRECKLES" ON DAIRY EQUIPMENT

Freckles may be an asset to a smiling youngster, but on dairy equipment they can be a decided handicap. We mean those white deposits and water spots that so often show up on sanitary piping and other bright surfaces after cleaning . . . especially with hard water.

That's one reason why more and more dairy plants are turning to D-LUXE these days. D-LUXE provides a new and different type of water-softening action that assures trouble-free cleaning . . . a unique free-rinsing action that produces a spot-free, "like new" appearance to all surfaces.

Furthermore, D-LUXE goes after dirt on pasteurizing vats, sanitary pipe lines and fittings, tanks and other equipment with a powerful emulsifying action that literally shatters grease . . . breaks it up into tiny globules which float in the cleaning solution (makes an emulsion just like butterfat in milk)!

Efficiently cleaned with D-LUXE, dairy equipment can be made to last longer . . . work better . . . can meet the urgent demands for greater output.

THE DIVERSEY CORPORATION,
53 West Jackson Blvd., Chicago 4, Ill.

Your advertisement is being read in every State and in 25 Foreign Countries

FOR ALL DAIRY SANITATION

B·K CHLORINE BACTERICIDE
REG. U.S. PAT. OFF.

Every year, because of poor quality, enough milk and milk products to meet the annual nutritional needs of 120,000 soldiers are wasted. This statement, issued by a University of Illinois College of Agriculture authority, calls for action.

For *fast* action, the answer is B-K Chlorine Bactericide . . . in up-to-the-minute dairies and creameries. Its available chlorine goes right to work as a sanitizer. Efficient and rapid, it costs little to use. Use B-K daily as a sanitizing rinse, and a helpful shortcut to increased butter production . . . through decreased rejections.

Dept. DS, B·K Division
PENNSYLVANIA SALT MANUFACTURING COMPANY
Chemicals
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ACCEPTED BY PUBLIC HEALTH AUTHORITIES

Our bulletin 30c is fully descriptive—Write for it.

"THE GAULIN TWO STAGE HOMOGENIZER AND HIGH PRESSURE PUMPS have met the Dairy Industries needs for a durable, heavy duty and economical machine, since 1909. Homogenizers and Pumps are still available with proper priority ratings, as well as repair and replacement parts. Both machines are strictly sanitary and are approved by all leading health boards. The Homogenizers are built in sizes from 75 gallons to 2000 gallons per hour, and the High Pressure Pumps are custom built to suit individual needs. The Gaulin is the ideal, all-purpose machine for fluid milk, ice cream, evaporated milk, condensed milk and spray-drying milk or eggs."

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THE MANTON-GAULIN MFG. CO., INC.
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"HANSEN'S"
Dairy Preparations

Cheese Rennet and Color
Annatto Butter Color
Certified Butter Color
Ice Cream Color
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—★—
Odorless Dairy Fly Spray
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CHR. HANSEN'S LABORATORY, INC.
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Marschall
RENNET and COLOR

For best results in the cheese vat, specify Marschall's. High in strength, pure and uniform.

MARSCHALL
DAIRY LABORATORY, INC.
MADISON 3, WISCONSIN

WHAT WILL YOU NEED POSTWAR?

We don't know how soon "postwar" will be. We do know that it will bring you new problems. Some of these will have to be solved for—and with—you by your equippers and suppliers. *What will you expect of them that you did not need prewar?* Tell them now—or tell their international association—

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LOW-COST Way to Can Washing Efficiency!

Increasing numbers of dairies, creameries, milk and ice cream plants are getting sanitary, odor-free cans . . . overcoming hard water conditions in their can washing . . . the low-cost way! They are using that specialized detergent,

OAKITE COMPOSITION No. 82

This performance-proved material has a dual purpose: its vigorous yet safe cleaning action gives you sanitary cans . . . its unique lime-solubilizing properties retard lime-scale formations in lines, jets and spray heads! Write for details . . . TODAY!

OAKITE PRODUCTS, INC.,
Dairy Research Division,
16G THAMES STREET, NEW YORK 6, N. Y.
Technical Service Representatives Located in All Principal Cities of the United States and Canada

OAKITE Cleaning

FLAV-O-LAC FLAKES

THE CULTURE

of definitely better flavor & aroma-producing qualities.

The standard with foremost operators, agricultural schools & colleges.

FLAV-O-LAC FLAKES (shown) produce a quart of the finest starter on a single propagation. Single bottles $2.00.

SPECIAL FLAV-O-LAC FLAKES "40"

produce 40 quarts of starter on a single propagation. Single bottles $3.00

Free Culture Manual of Fermented Milk Products on request.

Pioneers in Spectro-chemical, Chemical and Fluoro-photometric Determinations of Vitamins A, B_1, B_2, Nicotinic Acid, Pantothenic Acid, B_6, C & E in Dairy and Food Products. (Vitamin D excluded) inquiries invited.

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Students can readily use The Performance Register of The American Guernsey Cattle Club for

Progeny Studies—Ancestor Studies

Write for pedigree scratch pads, forms furnished free for the use of students in writing pedigrees.

We invite special research studies with both faculty and student encouragement and assistance.

KARL B. MUSSER, *Secretary, Treasurer*

THE AMERICAN GUERNSEY CATTLE CLUB

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Membership. Any person is eligible to membership who is formally announced by an Agricultural College or Experiment Station, or by the Bureau of Dairy Industry of the United States Department of Agriculture or by the Canadian Department of Agriculture as an instructor, extension worker, investigator, or administrative officer connected with the dairy industry, or any person filling a position of responsibility connected with the dairy industry who has had a college or university training in technical science, or any person filling a responsible position in the dairy industry of a professional character requiring a technical knowledge of dairying of a high order. The membership fee is $5.00.

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Dairy-D Vitamin D Concentrate is quickly and easily incorporated in the milk. No special equipment is needed. In the finished bottle of milk it is both odorless and tasteless. Dairy-D is reasonably priced.

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